TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

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Knowledge Management and Retention

A Case of a Water Utility in Finland

Julkaisu 1476 • Publication 1476

Tampere 2017

Tampereen teknillinen yliopisto. Julkaisu 1476
Tampere University of Technology. Publication 1476

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Thesis for the degree of Doctor of Science in Technology to be presented with due permission for public examination and criticism in Rakennustalo Building, Auditorium RG202, at Tampere University of Technology, on the 9th of June 2017, at 12 noon.

Tampereen teknillinen yliopisto - Tampere University of Technology
Tampere 2017

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ISBN 978-952-15-3954-1 (printed)
ISBN 978-952-15-3959-6 (PDF)
ISSN 1459-2045

Sandelin, S. 2017. Knowledge Management and Retention: A Case of a Water Utility in Finland. Tampere University of Technology. Publication 1476.

ABSTRACT

Knowledge management has been discussed and debated world-wide since the beginning of the 1990s. Over the years, knowledge management has become important due to an increased awareness of the importance of knowledge for an organisation's prosperity and survival, and due to the increased availability of information technology to store, distribute and generally manage knowledge.

The shared opinion globally and in Finland is that water utilities, where most of the larger water utilities are integrated and provide both drinking water and wastewater services, face continuous challenges with the changes of physical and operational environment and with rapidly ageing personnel. Because knowledge management, especially tacit knowledge, is a critical success factor for water utilities when striving for better and more sustainable performance, utilities should manage both explicit and tacit knowledge and transfer them to new generations of employees.

This dissertation deals with knowledge management at one Finnish utility. The following research questions are addressed: (i) how do personnel at water utilities interpret the concepts of information, knowledge management and tacit knowledge, and how is knowledge captured and shared; (ii) what information needs do personnel have in performing daily tasks and what acquisition channels do they use; and (iii) what is the role of formal and informal networks in performing daily tasks and gaining new knowledge.

The approach of this research is qualitative and contained both longitudinal and cross-sectional time horizons. The personnel of the same water utility were interviewed with a semi-structured questionnaire in 2004 and in 2013. The interviews were analysed by combining qualitative and statistical methods. Multiple sources of evidence on knowledge management practices at water utilities and in organisations was gathered in thematic workshop sessions in 2010 and in 2011.

One of the interesting findings was that interpretations of knowledge management had changed from informing people in 2004 to understanding knowledge management as personal, individual property in 2013. The personnel were proud of the knowledge they owned of the water treatment processes. This knowledge was considered technical knowledge, which is critical to the livelihood of the utility. There were many ways to share information and knowledge and a number of reasons were found explaining why knowledge sharing was considered difficult. The most important difficulties mentioned included lack of time, competing priorities, organisatorial barriers, sharing attitudes and atmosphere, a gap between older and younger people, and unwillingness to share.

In 2004 tacit knowledge was an unknown concept while in 2013 the concept was quite clear to most of the personnel. Tacit knowledge was highly valued and it was associated with the skills and knowledge

gathered over the years working at the same water utility. Tacit knowledge was shared in normal daily work and especially during malfunctions.

Information needs and usage at the utility were versatile and depended on the tasks performed by the employees. Almost everyone (over 90%) needed technical information on equipment, and over 60 percent needed knowledge of legislation. This research showed that the personnel used personal files, document collections, the internet and the intranet more often in 2013 than in 2004. The shift from printed material to electronic material has increased over the years. At the same time discussion with closest co-workers kept its importance.

The traced networks in trade union and professional association membership of the personnel indicate that assistance for solving professional challenges is not sought from these sources. The most important network was the closest co-workers, concerning the solutions to problems related to daily tasks. The results showed that external networks were large, quite stable and included multiple sectors. The professional networks consisted of task-relevant contacts, and every interviewee had individual contact networks.

Knowledge management requires long-term planning and actions. In this research it was clear that the top management should take responsibility for knowledge management at the utility. They should set strategies and approaches for knowledge management actions and ensure time allocations and tools for knowledge sharing. It is important to specify which kind of knowledge is valuable and worth retaining from the information overload.

Empirical findings from tacit knowledge, knowledge capturing and sharing, professional networks and knowledge retention at water utilities contributed to the understanding of the importance of knowledge management and knowledge retention. A limitation of this research is that it deals thoroughly with one water utility only. Thus, the results of this study are neither universally applicable nor directly applicable to water utilities of the same size. Yet, the gained results were supported by the evidence from multiple water utilities and water sector organisations.

The most important scientific contribution of this dissertation is that knowledge management was explored comprehensively in a sector that has not been studied extensively earlier. The results contribute to the body of scholarly literature in information and knowledge acquiring, creation, sharing and retention of water utilities. The study, among other things, found that a more in-depth study is needed to find out how knowledge management and retention differ at water utilities of different sizes and what effect ownership has on them. More research is also required of the demographic changes at water utilities, especially the effect of new generations on the way water utilities will operate in the future.

Keywords: Knowledge Retention, Water Utility, Social Networks, Tacit Knowledge, Storytelling, Information Needs, Knowledge Acquisition, Lifelong Learning, Longitudinal Research

Sandelin, S. 2017. Tietämyksenhallinta ja tiedon säilyttäminen: tapaustutkimus suomalaisella vesihuoltolaitoksella (Knowledge Management and Retention: A Case of a Water Utility in Finland). Tampereen teknillinen yliopisto. Julkaisu 1476. (Alkuperäinen englanniksi).

TIIVISTELMÄ

Tietämyksenhallinta on ollut organisaatioiden kiinnostuksen kohteena 1990-luvun alusta lähtien. Vuosien kuluessa pääpaino on siirtynyt entistä enemmän tiedon luomiseen, käyttöön ja säilyttämiseen organisaatioissa, kumppanuuksien luomiseen verkostoissa sekä tietotekniikan hyödyntämiseen. Vesihuoltoalalla tietämyksenhallinta on saanut ansaitsemaansa huomiota vasta viimeisimmän kymmenen vuoden aikana. Siitä huolimatta vesihuoltolaitosten henkilökunnan tiedon tarpeita ja informaation käyttöä päivittäisissä työtehtävissä ei ole juurikaan tutkittu.

Vesihuoltolaitosten osalta tietämyksenhallinnasta on tulossa kriittinen menestystekijä, sillä niin Suomessa kuin maailmallakin laitosten toimintaympäristö muuttuu jatkuvasti ja niiden henkilöstö suhteellisesti ikääntyy. Vesihuoltolaitosten pyrkimys parempaan ja kestävämpään toimintaan edellyttää tietämyksenhallintaa sekä hiljaisen tiedon keruuta ja siirtoa uudelle työntekijäpolvelle.

Tässä tutkimuksessa tarkasteltiin tietämyksenhallintaa suomalaisella vesihuoltolaitoksella. Tutkimuksessa haettiin vastausta kolmeen tutkimuskysymykseen: (1) Mitä tietämyksenhallinnalla käsitteellisesti ymmärretään, mitä hiljainen tieto on, miten se ilmenee ja siirtyy, mitkä tekijät vaikuttavat sen jakamiseen ja miten se on otettu huomioon organisaation toiminnassa; (2) Mitkä ovat vesialan henkilöstön tiedonhankintatavat ja –lähteet; sekä (3) Miten vesihuoltolaitos on verkottunut ja mikä merkitys verkostoilla on ammatillisesti sen työntekijöille ja koko laitokselle.

Tutkimus oli kvalitatiivinen ja siinä käytettiin sekä pitkittäistä että poikittaista tapaustutkimusta. Tutkimus käsitti kirjallisuuskatsaukset sekä haastattelut, jotka toteutettiin vuosina 2004 ja 2013 samalla kohdelaitoksella. Haastattelut analysoitiin sekä laadullisesti että tilastollisesti. Tutkimuksen kohdevesihuoltolaitoksena oli Porin Vesi, joka on keskisuuri suomalainen vesihuoltopalveluiden tuottaja. Lisäksi vuosina 2010 ja 2011 työpajoissa kerättiin aineistoa hiljaisesta ja kriittisestä tiedosta sekä tietämyksenhallinnasta vesihuoltoalan ammattilaisilta.

Vuonna 2004 vesilaitoksen henkilökunta tulkitsi tietämyksenhallinnan lähinnä merkitsevän asioista tiedottamista. Käsitys tietämyksenhallinnasta oli muuttunut seurantajakson aikana, ja vuonna 2013 se ymmärrettiin henkilökohtaiseksi omaisuudeksi. Henkilökunta oli ylpeä osaamisestaan ja tiedoistaan, jotka olivat kriittistä, teknistä tietoa laitoksen prosesseista ja toiminnasta. Informaatiota ja tietoa jaettiin yhdessä työskentelemällä, epävirallisissa keskusteluissa, kokouksissa, tarinankerronnassa, mentoroinnissa, mestari-kisällisuhteessa ja audiovisuaalisin keinoin. Tutkimuksessa ilmeni useita syitä siihen miksi tietoa ei oltu kuitenkaan valmiita jakamaan, mm. ajan puute, tärkeämpinä pidetyt tehtävät, organisaatiorakenteet, asenteet ja tiedon jakamiskulttuuri, sukupolven välinen kuilu ja haluttomuus tiedon jakamiseen.

Vuonna 2004 hiljainen tieto oli varsin tuntematon käsite, mutta vuonna 2013 se oli jo useimmille tuttu. Hiljaista tietoa arvostettiin, ja se liitettiin vuosien kuluessa hankittuun osaamiseen ja tietoon. Hiljaista tietoa jaettiin päivittäisten tehtävien yhteydessä ja erityisesti poikkeustilanteisiin liittyen. Henkilökunta oli huolissaan eläköitymisestä ja tiedon katoamisesta. Eläköityvillä oleva tieto menetetään, mikäli tiedon keräämiseen ei kiinnitetä ajoissa huomiota.

Informaation ja tiedon tarpeet vaihtelivat työntekijäryhmittäin ja tehtävittäin. Miltei kaikki työntekijät (yli 90 %) tarvitsivat laitteiden teknisiä tietoja, ja lainsäädäntöön liittyvää tietoa tarvitsi liki 60 % henkilökunnasta. Tutkimuksen mukaan henkilökunta käytti henkilökohtaisia tiedostoja ja materiaaleja, internetiä ja intranetiä useammin vuonna 2013 kuin vuonna 2004. Elektroniset materiaalit ovat syrjäyttäneet painetut aineistot. Keskustelut lähimpien työntekijöiden kanssa ovat kuitenkin säilyttäneet asemansa tiedon välityksessä.

Vesihuoltolaitoksen ja henkilökunnan verkostoitumista tarkasteltiin sekä ammatillisten järjestöjen ja ammattiliittojen että työtehtäviin liittyvien verkostojen näkökulmasta. Tutkimuksessa havaittiin, että työhön liittyvien haasteiden ratkaisemisessa ei juuri hyödynnetä ammatillisia järjestöjä eikä ammattiliittoja. Tärkeimmän verkoston muodostivat lähimmät kollegat, joiden puoleen ongelmatilanteissa ensiksi käännyttiin. Vesihuoltolaitoksen ulkopuoliset verkostot olivat laajat ja vakiintuneet, ja ne edustivat useita toimialoja. Jokaisella haastatellulla oli omiin työtehtäviin liittyvät kontaktiverkostonsa.

Tietämyksenhallinta edellyttää pitkäaikaista suunnittelua ja toimintoja. Tutkimus osoitti, että vesihuoltolaitosten johdon tulee ottaa vastuu tietämyksenhallinnasta ja luoda strategia ja tietämyksenhallinnan toimintokokonaisuudet. Tiedon jakamiselle on annettava aikaa ja tehokkaat välineet. Tärkeää on myös määritellä, mikä tieto on vesihuoltolaitoksen toiminnan kannalta merkittävää ja kriittistä sekä säilyttämisen arvoista.

Tieteellisesti tämä tutkimus lisäsi ymmärrystä tietämyksenhallinnasta, hiljaisesta tiedosta, tiedon jakamisesta ja säilyttämisestä sekä verkostoitumisen tärkeydestä vesihuoltolaitoksilla. Tutkimuksen kohteena oli vain yksi vesilaitos, mutta tuloksiin saatiin vahvistusta muiden vesihuoltolaitosten ja vesialan organisaatioiden kokemuksista.

Tutkimuksen pohjalta nousee esiin useita tutkimusaiheita. Miten tietämyksenhallinta ja tiedon säilyttäminen muuttuvat, jos laitosten omistuspohja on muu kuin kunnallinen liikelaitos? Mikä on ammatillisten verkostojen ja ammattikirjallisuuden merkitys vesilaitosten kehittämisessä? Vesilaitosten työntekijöiden ikäjakauman muutokset ja nuorten sukupolvien vaikutus laitosten toimintaan tulisi myös tutkia.

Hakusanat: tietämyksenhallinta, vesihuoltolaitokset, verkostoituminen, hiljainen tieto, tarinat, tiedontarve, tiedonhankinta, oppiva organisaatio, pitkittäistutkimus

ACKNOWLEDGEMENTS

This dissertation was prepared for the Faculty of Business and Built Environment at Tampere University of Technology, Finland. The Capacity Development in Water and Environmental Services (CADWES) research team has been the home base for this work, and without the support from the group members, I would not have made it to this point.

First, my special thanks go to my advisors, Adjunct Professor Dr Tapio Katko and Adjunct Professor Dr Jarmo Hukka, who patiently encouraged me to carry on with the dissertation. Your comments and sometimes critical evaluations helped me to finally find the path towards the most desirable decisions. Tapio and Jarmo, I still remember the research week, some 15 years ago in Lapland, which was in a way the starting point for this journey. I am the last one of the group to defend a dissertation, so, heartfelt thanks for having faith in me and my ability.

I owe a debt of gratitude to Dr Pekka Pietilä for valuable comments during the research, and to all other members of the CADWES research team for encouraging comments during the team meetings. I am likewise indebted to Dr Antero Luonsi for asking me year after year the same question: Is it finished? Now I can finally say: It's done.

This research would not have been possible without help from the real water professionals. I am grateful to the entire personnel of Pori Water for giving of their time for the research. The lively discussions during interviews were also learning experiences for me. I would especially like to thank the current director, Ilkka Mikkola, and the former director, Marja Luntamo, for their open-minded attitudes towards the research.

I wish to thank all participants of the Water Services Leadership and Development Continuing Education Programme (VETO-Vesihuollon johtamisen ja kehittämisen koulutus, WASLED) training sessions in 2010 and 2011, who in a complimentary manner participated in this study. Your water utility and administrative level experiences gave me valuable practical knowledge and thoughts for this dissertation.

I am indebted to the pre-examiners of this dissertation, Professor Eija Vinnari from University of Tampere and Professor Neil Grigg from Colorado State University for constructive comments and advise.

The proofreading of this dissertation was done at Lingsoft Language Services Oy. Thank you very much for correcting my text to follow the academic writing style.

I would also like to thank everyone who, in one way or another, contributed to the finalization of this book.

From 2004 to 2006 this research was supported by scholarships granted by the Finnish Cultural Foundation, the Soil and Water Foundation, the City of Pori and the former Faculty of Technology and Maritime Management at Satakunta University of Applied Sciences, and all of this support is gratefully acknowledged.

Finally, I want to thank my family, and particularly recognise my dear son, Markus, who is now taking his first steps in the academic world. Because of your unbelievably great success on the matriculation examinations in 2015 and your getting accepted into Aalto University School of Business, Mother got an extra boost to complete her dissertation.

It has been a long journey of both joy and sorrow to arrive at this point. Thus, the lyrics, ‘Stayin’ Alive’, have a special meaning to me.

May 9th, 2017, Pori, Finland

Sirpa Sandelin

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LIST OF ABBREVIATIONS

APQC	American Productivity and Quality Center
AWWA	American Water Works Association
AWWARF	The American Water Work Association's Research Foundation (since 1.1.2009 Water Research Foundation)
BOD_7	Biological Oxygen Demand (standard test for 7 days)
CADWES	Capacity Development in Water and Environmental Services research team at Tampere University of Technology
CEN	European Committee for Standardization
ELY Centre	Centre for Economic Development, Transport and the Environment
Edutech	Centre for Professional Development at Tampere University of Technology (Täydennyskoulutus Eductech)
EurEau	European Federation of National Associations of Water Services
EWA	European Water Association
FIWA	Finnish Water Utilities Association (former name Finnish Water Works Association)
HVAC	Heating, ventilation and air conditioning
HUOVI	Continuity-management tool (Huoltovarmuusanalyysi in Finnish)
ICT	Information and Communication Technology
IRC	International Water and Sanitation Centre
IRC/WELL	International Water and Sanitation Centre/Water and Environmental Health in Developing Countries
IWA	International Water Association
KVVY	Water Protection Association of the Kokemäenjoki River
NESA	National Emergency Supply Agency (Huoltovarmuuskeskus)
PC	Personal Computer
PESTEL	Framework tool for analysis of political, economic, socio-cultural, technical, environmental/ecological, and legal factors
STREAM	Study into Resources and Management of Water and Sanitation Sector Resource Centres (STREAM Project)
Tekla Xpipe	Water and wastewater network information system design application
Trimble NIS	Pipeline design application
WASLED	Water Services Leadership and Development Continuing Education Programme (VETO-Vesihuollon johtamisen ja kehittämisen koulutus)

TERMS AND DEFINITIONS

Data	Symbols like numbers and characters, which do not tell the reader or creator anything
Critical knowledge	Knowledge that is vital for the survival of the organisation
Information	When meanings, purpose, and relevance in a certain context or environment are added to the data, information is created
Knowledge	Knowledge is derived from information by integrating perception, skills, training, common sense, and experiences into it
Knowledge management	Identification, creation, sharing, retention and managing of knowledge assets in organisations
Knowledge retention	Keeping the knowledge in the organisation; preventing knowledge losses
Social network	Informal or formal carrier of information and knowledge
Storytelling	Activity where stories are told and shared among employees in organisations
Tacit knowledge	Such knowledge which is embedded in the organisation, its people and processes, and which cannot be easily codified and shared
Tenure profile	Describes the personnel's working experience at the utility
Water utility	Integrated utility that provides both drinking water and wastewater services to its customers
Workplace orientation	Activity during which the new employee or new position holder is integrated to the organisation, its rules, regulations and practices

1 INTRODUCTION

1.1 Background

Knowledge and information management have been discussed worldwide since the beginning of the 1990s. Knowledge management has been studied especially in information and communication technology (ICT), information management, behavioural sciences, and business studies. The ICT sector has mainly used ICT in managing data and information. Information management has concentrated on individuals' and organisations' information needs, sources and use. For companies, there is generally great interest in knowledge management, organisational learning, and information and knowledge flows. It is worth noticing that, in the field of knowledge, the emphasis has gradually shifted from sharing to generation and retention, while in networking, partnership building has gained more attention. The information needs and acquisition of various professional groups, mainly managers, have been studied widely under information management. However, the information needs and acquisition sources of water utility personnel have hardly been studied by information scientists or water professionals.

No single definition for the term knowledge management exists. Yet, a commonly shared view is that in today's global and turbulent world, both explicit and tacit knowledge form a key strategic asset for any company or organisation. Knowledge and organisational learning are thus related to each other, and organisation's need to management knowledge resources as their success depends on these assets. The concept of knowledge management is closely related to several other concepts, such as data, information, knowledge, wisdom, explicit knowledge, implicit knowledge, tacit knowledge, knowledge creation, knowledge sharing, intellectual capital, human capital, and social capital. These concepts are understood in different ways depending on the context as the literature review of this dissertation shows.

The initial stage of researchers' interest in knowledge management issues was the International Water and Sanitation Centre's (IRC) project Study into Resources and Management of Water and Sanitation Sector Resource Centres (STREAM Project), 1997−2000, although the focus at that time was on water and sanitation sector capacity building and knowledge centres. The researcher was involved in the STREAM Project, which aimed at strengthening water and sanitation sector resource centres in Africa, Asia, Europe, and Latin America. The project was implemented and co-ordinated by the IRC in the Netherlands. Tampere University of Technology was a partner organisation of the STREAM Project, and one of the European Resource Centres. The STREAM Project dealt with capacity building, knowledge sharing, and networking, among other issues (Raschid-Sally et.al 2002, 7−14). In 2002 the project led to the formation of Streams of Knowledge, Global Coalition of

Water and Sanitation Centres. Capacity building, knowledge generation, partnership building, and resources mobilisation were the key focus areas of the Global Coalition in 2005.

In the water and sanitation sector, IRC has organised two electronic conferences on the theme 'knowledge management'. In 2004 the theme was 'Knowledge management: worth the effort?!', which concentrated on the topics of constraints, benefits, lessons learned, and scaling-up. The conference's executive summary (IRC 2004a) concluded that there has to be 'a clear common understanding of what knowledge management is and what it can do'. In 2005 the first session (IRC 2004b) of the electronic conference called 'The reality on the ground' again raised the question 'What do we mean by knowledge management?'. In 2002 – 2003 American Water Work Association's Research Foundation (AWWARF) sponsored the project on evaluation of knowledge management applications and tools at water utilities. The focus in the evaluation was on water utility data and information management systems and the use of information. It dealt mainly with the systems, structures and databases, which served as storage and dissemination platforms for explicit knowledge (Rosen et al. 2004, 1−34). No previous study has addressed the occurrence of tacit knowledge or provided evidence for information needs and acquisition channels at water utilities. The American Water Works Association (AWWA) organises annually conferences for their water utility members and knowledge management asset issues have been on the agenda. AWWA has worked, among other topics, in developing knowledge assets and utility workforce (AWWA webpage 2016). The European Water Association (EWA) emphasise the exchange of information and knowledge between professional experts contributing to the sustainable water management. Their work is related to technical and policy issues (EWA webpage 2016). In Finland the Finnish Water Utilities Association (formerly named Water and Waste Water Works Association, FIWA) works to safeguard and promote the interests of its member utilities and to enhance their professional skills (FIWA webpage 2016).

However, there is still a lot of work to be done to promote the importance of knowledge management at water utilities. In the water and sanitation sector, knowledge management has not been understood in its broadest possible sense. The general finding is that in the water and sanitation sector information and knowledge are either incorrectly interpreted or treated as synonyms.

At this point it should be noted that although water utilities have similarities with other public utilities they have features that are unique for them. Rosen et al. (2004, 2) paralleled water utilities partly with commercial business and government agencies, because of similar activities in invoicing, customer relations management, operation and maintenance, human resources management, and engineering. However, compliance with regulatory requirements disassociate water utilities from business entities. Pietilä et al. (2010, 3) override the argument that water services can be treated similar to electricity, energy, transport and telecommunications services. The key characteristics of water service were discussed, i.e. water as a basic need and a human right, water as an economic good, water as a public good, water as a non-substitutable good and water as a local resource. Based on their research Pietilä et al. (2010, 3−13) concluded that water services should be

examined according to the PESTEL analysis, i.e. investigating political, economic, socio-cultural, technical, environmental/ecological, and legal factors. The unique features of water services depend on when and where provided.

Water utilities produce significant amount of data and information from treatment processes, network designs, customers, stakeholders, human resources, financial administration, statistics, etc. To achieve better and more sustained performance, water utilities should manage their knowledge assets. They should have a better understanding of knowledge they already have and what knowledge is needed to the provision of more efficient water services and to the develop water utility management.

In the last few decades, there has been much discussion about the ageing personnel and possible knowledge disappearance at water utilities internationally and in Finland. The crucial questions are how the generation gap will be filled, and especially knowledge will be sustained in utilities. Key elements of knowledge, its capturing, sharing and retaining practices at water utilities are important, but understudied in Finland, and this is a cause for concern.

FIWA reported in 2003 the key findings of a personnel study of Finnish water utilities. The study, performed in 2002, concentrated on the personnel structure and tasks, the age of personnel, basic education, further training, and outsourcing of service production. An alarming finding was that 40 percent (2000 members) of the personnel of respondent Finnish water utilities would retire or leave the work force by 2012 (Vesi- ja viemärilaitosyhdistys 2003, 7). A similar study implemented in 2010 showed that almost 50 percent of the personnel (1667 members from respondent utilities) will retire by 2022. A positive development was that the share of personnel without any formal education decreased from 25 in 2002 to 18 percent in 2010. Respectively, the share of vocational education had increased from 45 to 54 percent (Hallikas 2011,13−16). The total number of water utility personnel had decreased by almost by 17 percent.

The situation with ageing water utility personnel is similar all over the world. Water utilities do not attract younger people, and the retirees' valuable know-how will disappear if water utilities do not properly address this problem. In 2005 Post and Breen (2005, 45) reported that in the USA, 25 percent of the water utility workers would retire by the year 2010, and 40 percent by the year 2015. Despite recognition of the challenge and measures that need to be taken, retirement of the personnel at water utilities is still alarming. These figures are quite comparable to the Finnish situation as shown in previous paragraph.

The research developed gradually over an extended period of time. The genesis of this dissertation can be traced back to the time when the researcher studied information and knowledge management, which she completed at the Faculty of Information Sciences of the University of Tampere in 2003. She discovered that the terminology related to information, knowledge, and their management had not yet been established, and the interpretation of these concepts depended on the discipline and person dealing with them. Information needs and channels have been studied in

many fields but so far not extensively in the water and sanitation sector. This information gap was the initial reason for starting this study in 2004. To the author's knowledge, the first phase of this study was the first attempt to examine the information needs of water utility personnel in Finland. The results of the first phase (2004−2006) created a need to gain deeper understanding of what was understood by knowledge concepts, especially tacit and critical knowledge, in other water utilities and organisations dealing with water utility monitoring and regulation. Originally, the intent was to carry out the research on these topics, but when the researcher faced a cancer tragedy, the research work remained in the background for years. Due to difficult circumstances changes in the research process had to be accepted, although it meant extension of the timeline.

A new opportunity to proceed with the research opened in 2010, when Water Services Leadership and Development Continuing Education Programme (WASLED) started. Participants represented different-sized of water utilities and stakeholders in the Finnish water sector. The target group, i.e. participants of this education programme, met the original plans of integrating different-sized of water utilities and water sector stakeholders in the research. Furthermore, knowledge management and especially tacit and critical knowledge was included in the education programme as minor topics. The WASLED training programme was repeated in 2011 with similar target group of water utility and water sector stakeholders. These two sessions formed the second phase (2010 – 2011) of this dissertation, and they were used for triangulations the data.

Over the years, there has been a dramatic increase in the amount of literature and studies on knowledge management. However, it was still hard to find literature or studies dealing with information, knowledge, tacit knowledge and knowledge management at water utilities. Meanwhile, new technology, especially developments in ICT technology, has increased knowledge of water utilities significantly. Because of these changes, a new approach had to be selected. The researcher thought that longitudinal study, which has been applied widely in the social sciences, would be worth applying in engineering, as well. Considering, that longitudinal study follows study subjects over a long period of time with repeated data collection, the case water utility studied in the first phase of the research was chosen to be re-examined once again in 2013. The third phase of the research describes how understanding of knowledge concepts, information needs and acquisition channels has changed over the years.

This dissertation deals with the question of how the personnel of water utilities interpret information, knowledge management, and tacit knowledge. The broader concept of learning organisation is outside of the scope of this study, since the focus is on knowledge assets and sharing of knowledge. Information and knowledge needs and acquisition channels were studied at one Finnish medium-size water utility. A deeper understanding of tacit and critical knowledge and knowledge retention was gained by collecting data from representatives from Finnish water utilities. In this study, the term water utility is understood as it is used in the Finnish water sector, where most of the larger water utilities are integrated, and provide both drinking water and wastewater services to their customers.

1.2 Research objective, purpose and research questions

This study deals with information, knowledge, knowledge management, knowledge retention and networking at water utilities. Carrying out the overall objective, i.e. the broader development objective, contributed to a better and more sustained performance of water utilities with more integrated management of knowledge assets. The purpose, i.e. the specific objective of this research, was to fulfil the lack of scientific understanding of information and knowledge resources and sharing practices at water utilities. Further understanding of the knowledge issues at water utilities were explored by the following research questions:

(i) How do personnel at water utilities interpret the concepts of information, knowledge management and tacit knowledge, and how is knowledge captured and shared?

(ii) What information needs do personnel have in performing daily tasks and what acquisition channels do they use?

(iii) What is the role of formal and informal networks in performing daily tasks and gaining new knowledge?

Answers to these questions are sought at a Finnish middle-sized water utlity where the study is conducted in the form of interviews with all personnel groups. To increase the validity of the findings triangulation is utilised in two sessions organised for experts from Finnish water utilities and water authorities.

Creation and sharing of knowledge is a topical question in almost all organisations, not least at Finnish water utilities. Organisations face demographic shifts when millennials enter into workplaces and baby boomers retire. The personnel possess a huge knowledge base, which should be captured and documented while they still work for the utility, in order to share with future generations. The question is how to get the personnel to share their knowledge, especially their tacit knowledge, to ensure knowledge retention at water utilities.

The first research question is addressed through a literature review on the terminology and interpretations of knowledge management. Water utilities have to manage information and knowledge assets to achieve their performance goals. However, little is known about what knowledge management and its different aspects mean to water utility personnel. Thus, practice-oriented research to illuminate the vast area of knowledge management is justified. The water utility personnel's general interpretation of the key elements of knowledge management – information, information acquisition, knowledge management and tacit knowledge − and whether knowledge is organisational or individual property is examined in the analysis of the information gained from interviews. Special emphasis is laid on tacit knowledge, how the personnel understand tacit knowledge, and what types of tacit knowledge exist at water utilities. The sharing culture, best

ways to increase knowledge in the utility, and possible reasons knowledge sharing is hindered will be traced.

The information needs of water utility personnel have presumably not been studied earlier in Finland, so this study is a first attempt to trace professional information needs, channels, and usage. The second research question examines these aspects. Because there are several personnel groups with different levels of basic education and skills at every water utility, the best information channels should be determined case by case. This research question also includes the determination of whether the information needs and acquisition channels had changed when analysed at the case water utility in 2013 compared to the situation in 2004.

The role of formal and informal networks and communities of practice is important as an information and knowledge channel. The answers to the third research question clarify the environment and stakeholders of water utilities, the scope of the networks, and the value of networks in professional skills development. The focus is on contacts at both the individual and utility levels, as well as the changes in such at the case water utility between 2004 and 2013.

The end-result includes recommendations for the improvement of knowledge assets' management at water utilities.

1.3 Philosophical framework

This dissertation focuses on knowledge management at water utilities in Finland. The theme of information and knowledge management, of course, has been explored in many disciplines, but not with the main concern of comprehension of concepts of knowledge management, professional information and knowledge needs and their acquisition channels, and knowledge retention at Finnish water utilities. As explained in Sub-chapter 1.1, water utilities are unique and complex entities, which accomplish both engineering and business tasks in challenging knowledge environments. Water utilities, like any other public utility or business entity, have to cope with uncertainty and change.

The pracademic research agenda for public infrastructure study suggested by W.T. Price (2001, 287−288) implied that both academics and practitioners should be integrated in management research at public utilities, such as water utilities. Theory and practice are non-contradictory; theory forms the frame for conducting research and both the gained empirical and the theoretical knowledge is valuable for practitioners.

The complex research field of water management was discussed by Hukka et al. (2007, 439−440; the author of this dissertation being one of the co-authors). They concluded that a variety of different disciplines, approaches and theories are needed in scientific research of water management, which incorporates both multidisciplinary and interdisciplinary fields. Water management should be studied

from different angles and key areas, such as technological, economical, organisational and managerial points of view.

The tradition in engineering-management oriented research differs from the laboratory scale experimental work but also from studies in social sciences. This is due to the problem orientation and the need to find solutions. The Capacity Development of Water and Environmental Services (CADWES) research team at Tampere University of Technology complies with the following approaches: pracademic, empirical research and tacit knowledge (Hukka et al. 2007, 432−440). The author of this dissertation is a member of the CADWES research team, and therefore, it was an obvious choice to follow the approaches of the team.

When dealing with the philosophical background of the research, several matters have to be considered. The philosophical framework describes the development of knowledge and the nature of that knowledge (Myers 2013, 24). In this dissertation the philosophical assumptions are based on qualitative research, although some longitudinal changes in information needs, acquisition channels and networking are processed statistically. The quantitative research approach is not applied to its full extent, since deeper statistical analysis and causal relationships were not considered applicable to this study. Yet, Guba and Lincoln (1994, 105) share the view that both qualitative and quantitative approaches can be used compatibly in any research paradigm. The ontology, epistemology and paradigm of this research are thus largely approached by the philosophical assumptions given by Guba and Lincoln (1994).

The constructivism paradigm is the most applicable paradigm for this dissertation, because it stresses the relativism of reality, i.e. local and specific constructed realities. It also is transactional and subjective, and its findings are created. Ontology, which relates to the nature phenomena and their characteristics, relies on relativism. Relativist ontology accepts that there are many truths, and facts depend on the viewpoint of the observer. Guba and Lincoln (1994, 110) state that in relativist ontology 'realities are apprehendable in the form of multiple, intangible mental constructions, socially and experientially based, local and specific in nature, and dependent for their form and content on the individual persons or groups holding the constructions'. Different realities may share some common elements. Both constructions and their realities can change, i.e. in cases where humans get more information or they become more sophisticated. The nature of knowledge in constructivism consists of constructions, and their interpretations give new constructs with shared consensus. The epistemology of constructivism is transactional and subjectivist and the findings are created in interaction between the researcher and the respondents. Constructions are interpreted using conventional hermeneutical techniques. 'The final aim is to distil a consensus construction that is more informed and sophisticated than any of the predecessor constructions' (Guba and Lincoln 1994, 108−113).

The use of the constructivism paradigm in this dissertation is based on the fact that reality is relative. The natural environment, or the context, of this dissertation is a case water utility in Finland and the

respondents are the utility's personnel at the time of the study. By exploring the research questions, further understanding was gained on what information needs and acquisition channels, including networks, the water utility personnel used, what was considered knowledge and tacit knowledge and how knowledge was shared. When conducting this research the researcher embraced the idea of multiple realities. This thesis presents the authentic mental constructs of the interviewees, which were created during the interviews. Each construct is unique and intangible, although some interviewees may have shared similar constructs. In the analysis phase, gathered constructs were interpreted in the attempt to find new, general consensus constructs. The outcome is thus subjectivist and value-laden. The nature of the knowledge in the research appears in the created reconstructs.

To follow the constructivism epistemology it was important to conduct the study in interaction between the researcher and the water utility personnel. The researcher was solely responsible for the data collection in all study actions. Collaboration with the personnel at Pori Water took place during individual interviews, and with Finnish water utilities and authorities during thematic WASLED group sessions. The aim of the individual face-to-face interviews with the personnel at Pori Water, the case utility, was to find out their understanding and thoughts about various information and knowledge-related concepts, or phenomena. Knowledge management issues are known through the subjective experiences of the individuals, and thus the researcher also accepts that there will be multiple truths of studied concepts.

The methodological approach is largely hermeneutic and dialectic. According to Myers (2013, 182−183) the purpose of hermeneutics is human understanding, i.e. 'understanding what people say and do, and why'. Qualitative research methods have been used in this dissertation to facilitate in depth and detailed studies of issues. The research produced a great deal of information, although, contrastingly, it reduced generalisability. Typical orientations in qualitative research are exploration, discovery and an inductive approach. In addition to qualitative findings, quantitative data has been used in the research. Qualitative data reveal what respondents have said, and quantitative data reveal numerals and trends across the respondent group. Combined methods, like data triangulation, are used to strengthen the study. It is common to triangulate qualitative research data from one case with data from another case or use different research methods, such as combinations of qualitative and quantitative methods (Yin 2014, 118−123; Patton 2002, 3−55, 247−248; Meyers 2013, 7−11).

Qualitative research can be inductive, deductive or both. The inductive approach is bottom-up, starting with the empirical data collection and analysis, and progressing via hypotheses towards general theory. The inductive approach is open-ended and explanatory (Myers 2009, 22−23), and thus, has been adopted in this dissertation. According to Saunders et al. (2011 124−129), the inductive approach has several features, which were realised in this dissertation as shown in Table 1.1.

The novelty value of this dissertation is the trace of conceptual understanding of the vast area of knowledge management at water utilities including the information needs and acquisition channels of the water utility personnel. Because there is a clear lack of prior research on these key study questions at water utilities, this dissertation is well justified. The researcher also reckons the fact that some of collected data might be unusable.

Table 1.1 Inductive approach features.

Emphasis on inductive approach by Saunders et al. (2011, 124−127)	**Appearance in this dissertation**
Gaining an understanding of the meanings humans attach to events	The purpose is to find out how the water utility personnel understand knowledge management, tacit knowledge and retention topics, what information needs they have and what information channels they use. Interpretation is used to understand the meanings attached to those concepts.
A close understanding of the research context	The research context consists of the theoretical background of the previously mentioned concepts and their appearance in the water utility environment in Finland in 2004 and 2013.
The collection of qualitative data	Interviews at Pori Water and at the thematic group sessions in WASLED programmes generated mainly qualitative data.
A more flexible structure to permit changes of research emphasis as the research progresses	During the long research period, the main emphasis on knowledge management and tacit knowledge remain the same. Deeper insight into tacit and critical knowledge in water sector is included in the research agenda in between the two interview phases.
A realisation that the researcher is part of the research process	The researcher of this qualitative research is responsible for the whole research process, from the planning, collecting and analysing of data, to the reporting of the findings according to the responsible conduct of research.
Less concern with the need to generalize	The basis is not to find a generalisable model for knowledge management and retention actions at water utilities. Each utility is unique, and thus the results can be considered a basis for recognising similarities and differences at other water utilities.

The time horizon of the research can be cross-sectional or longitudinal. Parts of this dissertation have been conducted with a repeated cross-sectional time horizon, while the other parts could be seen to fall under longitudinal research. Because knowledge management and especially tacit knowledge is a critical success factor for both water utilities as organisations and their personnel, the longitudinal research focused on the changes between 2004 and 2013 at a case water utility, namely Pori Water. The research questions addresses what information needs and acquisition channels the personnel used, what was considered knowledge and tacit knowledge, how knowledge was shared and what kind of change patterns could be found. The multiple sources of evidence for the critical

and tacit knowledge management, practices and tools were collected from other water utilities and water sector actors in repeated cross-sectional research sessions in 2010 and in 2011, and, when presented, show merged results of the two sessions. Thus, the main focus was on interpreting and understanding the phenomena more deeply.

The Chapter 2 describes research methodology and methods. The chosen research strategy, a case study approach, is dealt with in Sub-chapter 2.1, literature reviews in Sub-chapter 2.2, research settings in Sub-chapters 2.3 and 2.4 and finally, research evaluation criteria in Sub-chapter 2.5.

1.4 Research structure and timeline

This study provides an overview of knowledge and knowledge retention issues and explores how they are interpreted and utilised at a case water utility in Finland. Multiple sources of evidence of tacit and critical knowledge were also collected from other water sector actors.

The actual study was carried out in three main phases between 2004 and 2016:

1) *2004−2006: research related to theoretical background and interviews at Pori Water*
2) *2010−2011: research related to tacit and critical knowledge in the water sector*
3) *2013−2016: research related to theoretical background and interviews at Pori Water*

The main research actions, specific questions and contribution to this dissertation are shown in Table 1.2.

Table 1.2 Structure and timeline of the doctoral study.

Research activities	**Specific questions and actions**	**Contribution in the dissertation**
Outlining the objective, purpose and approaches for the first phase of the research (2004−2006)	Topic formulation, selection of a water utility, introduction to the theme, outlining objective, purpose and research approach	Chapter 1 Chapter 2
First phase of the literature review 2004	Definitions of information, knowledge, tacit knowledge, knowledge management and networking mainly from the point of view of information management sciences. Interpretations of knowledge components in the water and sanitation sector.	Chapter 3
Interviews at Pori Water 2004	How the personnel from top to bottom interpret the key elements of knowledge management and how knowledge is shared; how the personnel understand	Chapter 4

	tacit knowledge, and what types of tacit knowledge exist in the utility; what types of information personnel need in their daily tasks and from what sources do they search for it; which formal and informal networks are utilised in performing daily tasks and gaining new knowledge	
Structuring and writing the Licentiate Thesis (2004−2006)	Analysis of the data, discussion and interpretations of the findings, what conclusions and recommendations can be drawn up, critical evaluation of the research process	All chapters
Outlining objective, purpose and approach for the second phase of the research (2010−2011)	What is tacit and critical knowledge at water utilities, what retention means are in use	Chapter 1 Chapter 2
VETO-Vesihuollon johtamisen ja kehittämisen koulutus (Water Services Leadership and Development Continuing Education Programme, WASLED) January 23, 2010	Tacit knowledge at water utilities: what kind of tacit knowledge exists; where it exists or which personnel groups possess it Critical knowledge at water utilities: what is critical knowledge and what share of it is tacit knowledge; how is critical knowledge identified and captured; how critical knowledge is shared; how critical knowledge sharing is supported or rewarded	Chapter 5
VETO-Vesihuollon johtamisen ja kehittämisen koulutus (Water Services Leadership and Development Continuing Education Programme, WASLED) November 11, 2011	Tacit knowledge at water utilities: what kind of tacit knowledge exists; where it exists or which personnel groups possess it; what are the tools or means used to capture knowledge; what role do an organisation's directors play in knowledge management Critical knowledge at water utilities: what is critical knowledge and what share of it is tacit knowledge; how is critical knowledge identified and captured; how critical knowledge is shared; how critical knowledge sharing is supported or rewarded	Chapter 5
Outlining the objective, purpose and approaches for the third phase of the research (2013−2016)	Further definition of the objective, purpose and research approach	Chapter 1 Chapter 2
Second phase of the literature review	Definitions of information, knowledge, tacit knowledge, knowledge management and networking mainly from the point of view of water and sanitation sector	Chapter 3
Interviews at Pori Water 2013	How the personnel from top to bottom interpret the key elements of knowledge management and how knowledge is shared; how the personnel understand tacit knowledge, and what types of tacit knowledge exist in the utility; what types	Chapter 4

	of information personnel need in their daily tasks and from what sources do they search for it; which formal and informal networks are utilised in performing daily tasks and gaining new knowledge	
Structuring and writing the dissertation (2013−2016)	Analysis of the data, discussion and interpretations of the findings, what conclusions and recommendations can be drawn up, critical evaluation of the research process	All chapters
Presentation at the CIB World Building Congress 2016: Intelligent Built Environment for Life, June 1, 2016 Tampere, Finland	Presentation by Sandelin, S.: Importance of Retaining Knowledge at Water Works − Findings from Finnish Water Works	Chapter 4

The introduction of the dissertation presented the background of the research, its objectives and purpose and research questions, as well as the philosophical framework, structure and timeline of the research. Research methodology and methods are introduced in Chapter 2. The theoretical background of knowledge management and networking is described in Chapter 3. The main emphasis in the theoretical part is on the concepts and models of knowledge management as well as tacit knowledge, sharing of knowledge and knowledge retention. The results of the case study on Pori Water are shown in Chapter 4 and triangulation findings in Chapter 5. Results are discussed and the overall study is assessed in Chapter 6. Conclusions, scientific contributions and further research needs are presented in Chapter 7.

2 RESEARCH METHODOLOGY AND METHODS

Chapter 2 describes the approaches to collect and analyse data and criteria for evaluation. Figure 2.1 presents an overview of the study phases.

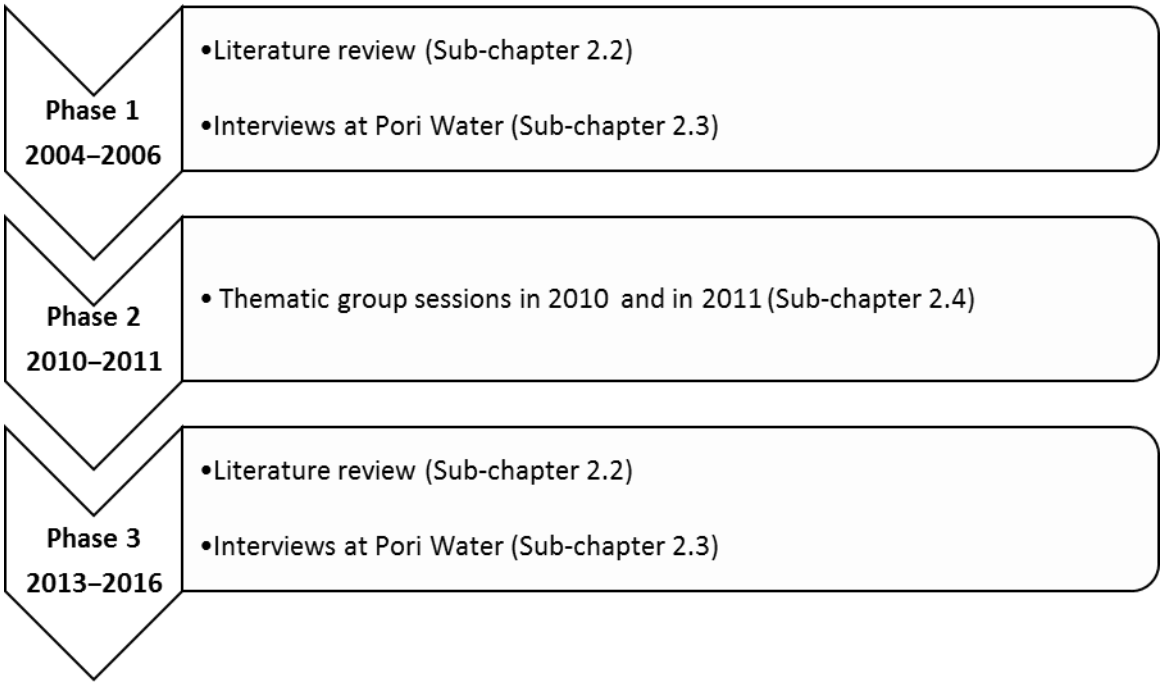

Figure 2.1 Three phases of the doctoral study.

2.1 The case study approach

Although some research has been carried out on knowledge and knowledge retention at water utilities abroad, there is very little scientific understanding of information, knowledge, tacit knowledge and networking at Finnish water utilities. The research questions in Sub-chapter 1.2 can be labelled as *how*, *why*, *who* and *what*, with the main focus on *how* and *who* questions. Case study methods provide a way to study *how* and *why* questions related to contemporary events in situations when the behaviours cannot be manipulated (Yin 2014, 9−15). The case study method is particularly useful in studies on knowledge of individuals, groups, organisations and social and political phenomena in business disciplines and social sciences (Yin 2014, 3−4). In engineering case study is a common approach to solve practical-oriented complex themes.

Yin (2014, 16) has defined the scope of a case study as 'an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident'. Besides the scope of a case study, Yin's definition has another focus, features of a case study inquiry which specify data collection and data analysis (Yin 2014, 17):

- *'copes with the technically distinctive situation in which there will be more variables of interest than data points, and as one result*
- *relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another results*
- *benefits from the prior development of theoretical propositions to guide data collection and analysis.'*

Mayers (2013) limits the definition of a business case study by pointing out that only cases dealing with 'a business-related issue in an organisation' would qualify as qualitative case study research in business (Myers 2013, 79). The definition proposed by Myers (2013, 78) is: 'Case study research in business uses empirical evidence from one or more organisations where an attempt is made to study the subject matter in context. Multiple sources of evidence are used, although most of the evidence comes from interviews and documents'. A case study as a study of social phenomenon is discussed by Swanborn (2010). His definition for a case study, which was attached to disciplines like sociology and administrative and organisational sciences, shares elements with Yin's and Myers'. Case studies are attached to 'a certain period' and focus on 'detailed descriptions, interpretations and explanations that several categories of participants in the system attach to the social process' (Swanborn 2010, 22).

Knowledge management is a prerequisite for a sustainable performance at water utilities. Taken together, the literature reviewed support the notion that knowledge management is insufficient researched at water utilities and there is a clear gap on the interpretations of the concepts related to knowledge management. Thus, to gain a detailed understanding of several concepts of information and knowledge related issues at a water utility, the case study approach was adopted in this research to gather empirical evidence. Yin, Myers (2013) and Swanborn (2010) shared similar thoughts about evidence. However, Yin's (2014) case study principles were selected to be followed in this dissertation, because of the broad scope and features of the case study. The most important concepts used in this dissertation include information, tacit knowledge, knowledge management, knowledge retention and networking. These phenomena were studied in two timely different continuums, in summer and autumn 2004 and in autumn 2013. The triangulating fashion, i.e. multiple evidence as featured by Yin (2014), was captured by obtaining further in-depth information on the knowledge in the water sector. The information from a water utility was triangulated with the data gathered from the participants of the Water Services and Leadership Development Continuing Education Programme (WASLED).

The use of the case study in this research can be justified by the fact that case studies are considered useful when the phenomena are studied in their real contexts, i.e. in this research in the real-world context in the natural setting of the same organisation, Pori Water. This case water utility is very similar to a business entity although it is owned by the municipality. The Local Government Act (410/2015, Chapter 9) stipulates that municipal companies conduct their tasks according to business principles. The primary function of water utilities in Finland is to provide water and wastewater services to the customers, and accomplish their duty strictly complying with the policies, legislation and regulations. Water utilities have management boards whose responsibility areas cover utility's administration, finances, operations, internal control and risk management. The director, the subordinate to the management board, is responsible for management and development of the activities at the utility. Managing knowledge is definitely one of the key administrative issues to be resolved strategically at water utilities. Knowledge management has social dimension, and water utilities comprise of internal and external social environments where personnel operate together with customers, companies, stakeholders, etc. The business-related and social process-related nature of the previously mentioned responsibilities strongly favour the use of a case approach in this dissertation.

Like any other research method, case study research has advantages and potential disadvantages. The advantages include, but are not limited to, the following: research is based on empirical work in an organisation, theories are tested in messy real-life situations, several methods can be included, participants can be engaged in the process, and it can explain why and how things happen. The main disadvantages are: the ability to compare data with other studies is not as prevalent as with other methods, case study findings lack generalisability, the researcher has no control over the situation, it might not be easy to focus on the most important issues, it produces substantial amount of documents, the data gathered is not easy to process, the researcher's personal involvement and subjectivity might disturb the setting, and it is very strict, demanding and time-consuming (Yin 2014, 19−23; Myers 2013, 82−83; Simons 2009, 23−24). The major concerns about rigorousness, generalisability, the unmanageable level of effort and comparative advantage, were noted but at the same time allayed by Yin, who eventually concluded that 'case study research is remarkably hard' (Yin, 2014, 19−23).

The disadvantages of the case methods were also discussed by Flyvbjerg (2006). He examined the common negative arguments attached to case studies and found five misunderstandings which he revised (Table 2.1). The case study approach applied in this dissertation leans on the following Flyvbjerg's arguments:

- *predictive theories and universals cannot be found in the study of human affairs, and knowledge is concrete and context-dependent*
- *it is not desirable to summarize and generalize case studies, and studies should be read as narratives in their entirety.*

Table 2.1 Case study arguments and their revised versions according to Flyvbjerg (2006, 219−245).

Common argument attached to case-study	Argument revised by Flyvbjerg
General, theoretical (context-independent) knowledge is more valuable than concrete, practical (context-dependent) knowledge.	Predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals.
One cannot generalize on the basis of an individual case; therefore, the case study cannot contribute to scientific development.	One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas 'the force of example' is underestimated.
The case study is most useful for generating hypotheses; that is, in the first stage of a total research process, whereas other methods are more suitable for hypotheses testing and theory building.	The case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone.
The case study contains a bias toward verification, that is, a tendency to confirm the researcher's preconceived notions.	The case study contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias toward falsification of preconceived notions than toward verification.
It is often difficult to summarize and develop general propositions and theories on the basis of specific case studies.	It is correct that summarizing case studies is often difficult, especially as concerns case process. It is less correct as regards case outcomes. The problems in summarizing case studies, however, are due more often to the properties of the reality studied than to the case study as a research method. Often it is not desirable to summarize and generalize case studies. Good studies should be read as narratives in their entirety.

2.2 Literature reviews

Literature reviews were essential stages in conducting this dissertation. Because of the longitudinal methodology, two literature reviews are involved. In both reviews knowledge management, the role of tacit knowledge at water utilities, networking and storytelling were reviewed in the literature survey. The sources were books, other printed material, electronic databases, online sources, and personal professional networks. The existing literature on knowledge management and tacit knowledge published before 2004 is extensive and focuses mainly on information, management sciences and social sciences. There is a relatively small body of literature concerned with information and knowledge management at water utilities. The related literature published between 2005 and 2013 reveals the emergence of an ageing and diminishing work force, especially in managing knowledge at water utilities.

2.3 Research setting at Pori Water

2.3.1 Interview arrangements

The field research was based on individual interviews, in which the semi-structured questionnaire form was used to save the answers during the interview directly to a computer. In the interviews, timing and topic orders were flexible. The length of a single interview varied from 45 minutes to 60 minutes.

The first phase of the field research was carried out at Pori Water, where 61 employees were interviewed from June to October 2004. Individual interviews were conducted with all personnel groups there. Altogether 65 percent of the employees were interviewed. Before the research started, the director of Pori Water notified the personnel of the research in writing. In her notice, and at the beginning of each interview, it was emphasised that the interviews were to be conducted on voluntary basis, and that all information given during the interview would be treated confidentially. The schedule for the interviews was made flexible so that the interviews did not disturb normal duties too much. The researcher scheduled times for interviews directly with almost all of the interviewees. In a couple of cases, the times were agreed upon with foremen.

The second phase of the field research was conducted nine years later from September to October 2013 at Pori Water, where 33 employees were interviewed. Again, individual interviews were conducted with all personnel groups. Altogether 47 percent of the employees were interviewed. Information about the forthcoming research was delivered as was done in the study in 2004. The only exception was that the interview schedule was agreed upon through the top management at Pori Water.

In the beginning of the data collection in 2004, altogether 20 interviews were tape-recorded. The remaining interviews (41) were not recorded, except the parts which contained stories. There was no need to record full interviews, because the answers could be entered in on a computer during the interview. Besides, some of the interviews and stories were not recorded at all because the interviewee denied it. The data collection procedure was the same in the 2013 interviews. A Nokia E7 mobile phone was used to record the 13 interviews in 2013. The remaining interviews (20) were not recorded according to the wishes of the interviewees. After the interviews, recorded materials were transformed into a written text for further analysis.

In 2004 interviews were carried out on the employer's premises, except for one interview, which was done at the Satakunta University of Applied Sciences. In 2013, all interviews were done on the employer's premises at Pori Water.

2.3.2 Interview questions and analysis

The semi-structured questionnaire contained both structured questions and open-ended questions. The structured questions dealt with information needs and acquisition, while the open-ended questions dealt with the interviewee's background information, stories, tacit knowledge sharing, personnel development needs, and informal and formal networks. Before the actual interviews in 2004, the questionnaire was pre-tested with three colleagues of the researcher on the CADWES research team at Tampere University of Technology. The questionnaire was the same in 2004 and 2013, except that in 2013, one additional question on social media and on workplace orientation was included.

Some of the questions were dichotomous, some had three or four answer options, some were categorised and some were scaled. For the dichotomous questions the answer options were 'yes' or 'no', and for the questions with three or four options, participants could choose from 'yes', 'no', 'difficult to say/do not know/partly', and 'some have'. The categorised questions constitute pre-coded classifications, like the question on daily information needs. A seven-step Likert scale was used for the structured questions. The questions related to usage of, for example, certain information sources were scaled as follows: 1=never, 2=a couple of times per year, 3=once per month, 4=a couple of times per month, 5=once per week, 6=a couple of times per week, 7=daily. Some of the questions measured, for example, the effect of certain means by which knowledge is increased. In these cases the used scale was the following: 1=very well, 2=well, 3=difficult to say, 4=some, 5=little, 6=very little, 7=no effect/not at all. Simple statistics were used to show frequency distributions, which show how the interviewees are distributed on different items. Analyses of the frequencies in 2004 and 2013 indicate change over time.

The purpose of using open-ended questions was, as Patton (2002, 21) stated, 'to understand the world as seen by the respondents'. The open-ended questions, like the question on the personnel's interpretation of knowledge management terminology (question 27), were analysed by coding the information into common sub-themes. Likewise, the gathered stories (question 31) were classified into categories. With the content analysis, which is a widely used qualitative research technique, the themes were further interpreted to identify core meanings. During the process words and sentences of the responses were analysed by comparing the key contents and interpreting the different underlying meanings, which produced distinct categories. A simple statistic was used to detect frequency changes between situations in 2004 and those in 2013.

The questionnaire (see Annex 1) focused on the following five main areas: (1) personal information: age, education, tasks, working history at Pori Water, information needs and sources, including social media in 2013 interviews; (2) how the interviewees interpreted information, information acquisition, knowledge management, and tacit knowledge; (3) stories, personnel development needs, and networking; (4) information and tacit knowledge sharing; and (5) workplace orientation practices in 2013 interviews.

The interviewees were not given the questionnaire. All the questions were posed to the interviewees at the actual time of the interview. A separate form containing answering options was given to the interviewees to be used with questions 18, 19 and 33. Some responses required elaborations, and further discussions clarified the conceptions of the interviewees. Sometimes the responses incorporated interesting thoughts about other themes related to water utility operation environment.

A semi-structured type of questionnaire was selected so that, as pointed out by Hirsjärvi et al. (2004, 197), collected data could be treated both qualitatively and quantitatively. However, the intention was not to make a deep statistical analysis of the data, but to find out frequencies, percentages, and mean values. The goal of using simple statistics was to obtain insight into changes over time. Some of the categories of questions were defined before the data analysis. Some new categories were created, and some of the existing categories were combined during the data analysis. The statistical data analysis was done by the Microsoft Excel spreadsheet software program.

2.4 Research setting in the Water Services Leadership and Development Continuing Education Programme

2.4.1 Thematic group session setting arrangements

In 2010, as part of the Water Services and Leadership Development Continuing Education Programme (WASLED), information on tacit knowledge and critical knowledge were gathered in thematic group sessions, where participants in the first phase wrote down their individual thoughts and in the second phase shared and discussed about tacit knowledge in groups based on their organisation type and size. In the third phase, groups summarised their findings to other groups. All reports were then collected together for deeper analysis. Participants were grouped by the type and size of the organisation into four groups: (1) organisations, associations, environment centres and water protection agencies (one group); (2) small water works (one group); (3) medium-size water works (two groups); and (4) large water works (one group).

In 2011, the research on individual thought was similar to the 2010 setting, but in the group phase each group concentrated only on one question of the five because of the limited time allocated in the programme schedule. Participants grouped freely into five groups. Summarisation of the group findings and deeper analyses were similar to those of 2010.

Twenty-two participants from various water authorities, organisations, associations and water works attended the tacit knowledge session in 2010, and 15 participants in 2011, at the Centre for Professional Development Edutech (Täydennyskoulutus Edutech) premises at Tampere University of Technology. The length of the session, including the introductory lecture on tacit knowledge at water works, was about two hours.

2.4.2 Questions in thematic group sessions

Structured questions were used during the WASLED thematic group sessions. In 2010, individual questions were: (1) what tacit knowledge exits at your water works or organisation; and (2) where is it or which personnel groups possess it. In 2011, two additional questions were included: (3) what are the means or tools used to capture tacit knowledge; and (4) what role does the top management have in knowledge management issues.

The group questions used in 2010 and in 2011 were: (1) what is critical knowledge, and what share of it is tacit knowledge; (2) how is critical knowledge identified and captured; (3) how is critical knowledge shared; and (4) how is critical knowledge sharing supported or rewarded. In 2011, the additional question was included in the set of questions: (5) how is the knowledge managed.

2.5 Criteria for evaluation of the research results

The criteria used to evaluate the research are reliability, validity, and ethical compliance, which will be addressed next.

Reliability expresses the consistency and replicability of the research (Hirsjärvi 2004, 216−218). Reliability means that 'if a later researcher follows the same procedures and conducts the same case study over again, the later investigator should arrive at the same findings and conclusion' (Yin 2014, 48−49). Thus, the documentation should be as comprehensive as possible to allow the research to be replicated.

Validity means the extent to which measures and research findings provide an accurate representation of the things they are supposed to measure (Hirsjärvi et al. 2004, 216). One of the validity strategies in qualitative research is triangulation. According to Patton, there are four types of triangulation, such as methods triangulation, triangulation of sources, analyst triangulation and theory/perspective triangulation. Incorporating triangulation in the research inquiry approach can strengthen research, because it can reduce systematic bias and distortion during data analysis. The final outcomes of the research will be based on multiple sources and multiple interpretations (Patton 2002, 556−563). Yin (2014, 121) notes that data triangulation helps to strengthen the construct validity of the research. With construct validity, Yin meant 'identifying correct operational measures for the concepts being studied'. Other types of validity are: internal validity, which is mainly used in explanatory or causal case studies for 'seeking to establish a causal relationship', and external validity, which refers to 'whether study's findings are generalisable beyond the immediate study' (Yin 2014, 45−49). In this dissertation, triangulation of sources, i.e. the use of data from multiple interviewees (personnel at Pori Water and participants of the WASLED programme), will be applied to the analysis of different phenomena. Thus, validity questions relate to construct and external validity.

Guba and Lincoln (1994, 115) pointed out that, in the constructivism paradigm, ethics is intrinsic because of the values of both the participants and the inquirers. The closed personal interaction between a participant and an inquirer may produce confidentiality and anonymity problems (Guba and Lincoln 1994, 115). The ethics of case study research is discussed, in regards to protecting human beings and conducting research with special care and sensitivity, by Yin (2014, 76−79). This dissertation involves dozens of human beings as subjects of information, so special attention has to be paid to sensitivity questions. Research ethics contain a broad set of values, and the Finnish ethical standards have been followed throughout this study.

The guidelines for the *responsible conduct* of research covers the whole process of research from conducting research, respecting previous work by other researchers, publishing results, rights and responsibilities of researchers, and communication with parties involved (Finnish Advisory Board on Research Integrity 2013, 30−31).

The *ethical compliance* of this research is based on responsible conduct guidelines given by the Finnish Advisory Board of Research Integrity and the ethical principles of research adopted in the humanities and social and behavioural sciences given by the National Advisory Board on Research Ethics. Ethical principles have been followed according to the nature of this research, i.e. the case study evidence data was collected in face-to-face discussions. The key ethical principles followed in this dissertation are: respect the autonomy of participants and the voluntary nature of participation; avoid harm, i.e. treat participants with respect and dignity; and protect privacy and protect data in publications (National Advisory Board on Research Ethics 2009, 5−13). The ethical compliance is discussed in detail in the assessment of the research in Sub-chapter 6.3.

3 INFORMATION, KNOWLEDGE, KNOWLEDGE MANAGEMENT AND NETWORKING

Chapter 3 describes the theoretical background of information, knowledge, knowledge management and networking. Sub-chapter 3.1 highlights the environment in which organisations work today. Data, information, knowledge, and knowledge management are discussed in Sub-chapter 3.2. The various approaches and models are derived from information and management sciences. Sub-chapter 3.3 discusses information and knowledge sharing in organisations with a special emphasis on tacit knowledge. An organisation's internal and external networks and workplace orientation are dealt with in this Sub-chapter, too. Key issues are on human capital, organisational learning and knowledge retention and some tools are dealt with in Sub-chapter 3.4. A brief summary of the Chapter 3 is provided in the Sub-chapter 3.5.

3.1 Turbulent knowledge environment

In today's global society, both explicit and tacit knowledge are strategic assets for organisations that have to cope with the complex and turbulent knowledge environment. The turbulence is mainly due to the quickly growing amount of knowledge and its fragmented and global nature. Businesses face growing complexity, and technology is needed to meet the complexity challenge (Probst et al. 2000, 5; Tryon 2012, 8). By *fragmentation*, Probst et al. (2000, 6) means specialisation within scientific disciplines; specialists from different disciplines do not perhaps understand each other. Figure 3.1 highlights the trends in the knowledge society.

The complex knowledge environment creates opportunities and threats. Products may be developed to be more intelligent, and services may include knowledge components, thus creating opportunities for new markets. One threat is that the lifetime of strategic knowledge will be short, meaning that creating new knowledge may open doors for competitors (Probst et al. 2000, 7). Another threat organisations may face is that the knowledge gap between what they need to know and what their personnel actually know may widen further (Tryon 2012, 6−8).

Baker et al. (2004) list trends in the public sector, including a diminishing workforce, growing private competition within the public sector, deterioration of employee loyalty and increasing public involvement in government. Baker et al. assume that efficient organisation will transform to organisation that 'fails to know what it already knows'. The realisation of trends would cause a shortage of management level employees, private competitors and joint ventures might absorb employees from utilities' management and operation levels, higher demands of employees might lead to willingness to change jobs, and higher accountability of resources might lead to streamlining utilities (Baker et al. 2004, 2).

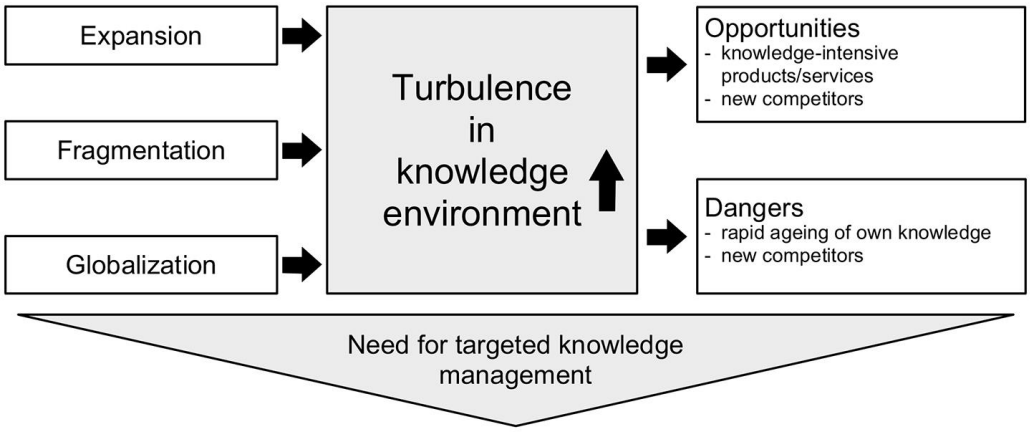

Figure 3.1 Knowledge and the society (adapted from Probst et al. 2000,6, Managing knowledge : building blocks for success by PROBST, GILBERT ; RAUB, STEFFEN ; ROMHARDT, KAI. Reproduced with permission of JOHN WILEY & SONS, INCORPORATED in the format Other Published Product via Copyright Clearance Center).

The Finnish water services development has been widely studied by Katko. His studies on Finnish waters services between 1996 and 2011 clearly show the turbulence in the physical and operational environment of water utilities. Finnish water services have developed hand-in-hand with economic development and industrialisation. Internalisation has also been present in the development of Finnish water services, when international technological developments have been applied in local Finnish water utilities. Development in legal framework on water pollution prevention and conservation and wastewater treatment requirements has happened fairly quick. Water services are tightly connected to external environments and factors, i.e. political, economic, social, technological, environmental and legal factors, which affect water utilities. In this macro picture, water services have to be viewed as a whole entity (Katko 2013, 428−444).

In the future, turbulence at water utilities will be similar to turbulence in any other organisation. The complexity of water management will increase when a food-energy nexus is added into water management developments. Geldof et al. (2011) studied complexity, the importance of tacit knowledge in complex water issues and the neglected value of tacit knowledge. Their conclusion was that different knowledge forms are needed to cope with the complexity of water management innovations in the future and to see beyond the immediate professional reality the actual complex reality. Water organisations need new types of craftsmanship, people who are able to see beyond their own field of profession, who can listen and tell stories and are willing to use modern technological tools, like social media (Geldof et al. 2011, 1−8).

The research on future challenges of the Finnish water services conducted by Heino et al. (2011) show that the biggest challenges are the aging infrastructure, vulnerability and risk management, and human resources and know-how. The most significant danger in human resources and know-how is related to the ageing personnel, the pattern of high retirement rates and water works' ability to attract younger employees. Neither water services nor education in that field has been seen as trendy among youth (Heino et al. 2011, 1−9).

3.2 Key concepts of information, knowledge and knowledge management

Knowledge management has several definitions depending on the discipline where it is used. Several other concepts, like data, information, knowledge, wisdom, explicit knowledge, implicit knowledge, tacit knowledge, critical knowledge, knowledge creation, knowledge sharing, intellectual capital, human capital, social capital, etc., are closely related to knowledge management.

Information and knowledge are difficult to define since both are given several meanings. In the Finnish language the difficulty is compounded by the fact that, in ordinary usage, the word *tieto* means either information or knowledge. Information is commonly used in a narrow sense to refer to data, i.e. facts and texts of literal significance (Buckland 1991, 7). Data is created from symbols like numbers and characters. Individual symbols do not tell the reader or creator anything. When meaning, purpose, and relevance in a certain context or environment are added to data, they become information. Knowledge, in turn, is derived from information by integrating perception, skills, training, common sense, and experiences into it.

In the case of the water supply and sanitation sector, the basic definitions can be clarified by the following simple example:

Symbols: 1 and 5 make

→ *Data: 15, which integrated into the wastewater parameter context gives*

→ *Information: BOD_7 15 mg/l, which in turn is integrated into*

→ *Knowledge: BOD_7 < 20 mg/l is the limit value for wastewater,*

thus the plant fulfils the treatment requirements.

In the following sections, information, knowledge and knowledge management are reviewed from different perspectives of information and management sciences, including applications in the water sector.

3.2.1 Some characteristics of information and knowledge

Buckland (1991) has studied information from three points of view: as a process, as knowledge, and as a thing (Table 3.1). When talking about information and, especially, knowledge, the entity and process as well as the intangible and tangible characteristics have to be separated.

Table 3.1 Information and its aspects (adapted from Buckland 1991, 6, *Information and Information Systems* by Michael Buckland. Copyright © 1991 by Michael Buckland. All rights reserved. Reproduced with permission of ABC-CLIO, LLC, Santa Barbara, CA).

	Intangible	**Tangible**
Entity	Information-as-knowledge Knowledge	Information-as-thing Data, document, recorded knowledge
Process	Information-as-process Becoming informed	Information-as-processing Data processing, document, knowledge engineering

Devlin (1999, 33−36) emphasised the crucial role played by the encoding scheme in the storage and transmission of information, and stated that information is a sum of representation and procedure for encoding or decoding. Devlin also used another equation, where information was a sum of representation and constraint. The term ‘constraint’ refers to the regularities and conventions that enable some configuration of objects to represent or store information. Anything can be representation, and scientific analysis of information begins with an examination of constraints. If the three ingredients – context situations or environments, the object or situation about which the information is being transmitted, and the constraints being used to transmit the information – are combined appropriately, the final result will be information (Devlin 1999, 27−36).

Buckland (1991) and Devlin (1999) express similar views on defining information, although the terminology they use is different. Devlin (1999, 12−17) also talks about information as a substance, which can be acquired, stored, and possessed either by an individual or by a group, and transmitted between individuals and groups. According to Devlin (1999, 15), information is fundamental and easier to get hold of than knowledge.

The difference between information and data is pointed out by Visscher et al. (2006), who stress context dependence of information, ‘By structuring data using our mental framework and subjectivity to explain or express something, we convert data into information, a set of data with relevance and purpose’. They also provide the term *indigenous knowledge*, which is used in the water and sanitation sector for describing local or traditional knowledge (Visscher et al. 2006, 8−11).

Sveiby (1997, 29−39) emphasises the multifaceted nature of knowledge: information, awareness, knowing, cognition, sapience, cognizance, science, experience, skill, insight, competence, know-how, practical ability, capability, learning, wisdom and certainty are among the terms associated with it. He shares the view that the definition depends on the context in which the term is

used. Sveiby's (1997, 37) own definition is that 'knowledge is a capacity to act'. Table 3.2 shows the distinctions between information and knowledge according to Sveiby.

Table 3.2 Differences between information and knowledge (adapted from Sveiby 1997, 40−50).

Information	**Knowledge**
Static	Dynamic
Independent of the individual	Dependent on individuals
Explicit	Tacit
Digital	Analog
Easy to duplicate	Must be re-created
Easy to broadcast	Face-to-face mainly
No intrinsic meaning	Meaning has to be personally assigned

Internalisation of information has to happen before people can use and benefit from it. In Devlin's (1999, 15) equation, knowledge is the sum of internalised information and the ability to utilise the information. He shares the common view that knowledge exists and is applied in the minds of individuals, i.e. knowers. Devlin (1999, 15) uses the expression fundamentally and intrinsically, making knowledge somewhat harder to pin down than information. Nonaka et al. (2000) base their work on the knowledge-creating process and on the definition of knowledge as 'justified, true belief', the philosophical definition given by Plato. Nonaka et al. (2000, 7) pay more attention to the 'justified' than the 'belief' part. In knowledge creation, Nonaka and Takeuchi (1995, 58, 60-61) consider knowledge to be 'a dynamic human process of justifying personal belief toward the truth', and they view distinct knowledge in two types, as shown in Table 3.3.

Table 3.3 Types of knowledge according to Nonaka and Takeuchi (1995, 61, reproduced with the permission from Oxford University Press).

Tacit knowledge (subjective)	Explicit knowledge (objective)
Knowledge of experience (body)	Knowledge of rationality (mind)
Simultaneous knowledge (here and now)	Sequential knowledge (there and then)
Analog knowledge (practice)	Digital knowledge (theory)

Davenport and Prusak (2000, 5−12) also highlight human complexity and predictability when they mention that values and beliefs may be more important organising, selecting, learning, and judging elements of knowledge. Of course information and logic play a certain role, too. Davenport and Prusak (2000, 5) define knowledge as follows: 'Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embossed not only in documents or repositories but also in organizational routines, processes, practices, and norms'. This definition has all the same elements as Wiig's corporate knowledge definition. Karl Wiig (1996), cited by Brooking (1996, 143), describes

the difference between corporate knowledge and information as follows: ‘Knowledge consists of truths and beliefs, perspectives and concepts, judgements and expectations, methodologies and know-how’.

Baumard (1999, 18−20) considered knowledge to be a continuum between interpreted information and the non-representables. In his continuum, a diagram represents the interpreted information, and intuition as well as anticipation is non-representable. He links information to common understanding, which modifies actors’ knowledge in different ways.

Probst et al. (2000, 18, 24) add the skill component to the knowledge discussion. They state that knowledge and skills acquisition is a slow, time-consuming process. They conceptualise the process as a continuum from data via information to knowledge (Table 3.4). It is an incremental process, where information is assembled and interpreted. This conceptualisation differs from Sveibys’ clear distinction between information and knowledge. Hasanali et al. (2003) studied employees’ work and professional development. They claim that knowledge should be embedded in the work whereby it can be captured, shared and reused during daily tasks. The value of this process is in that it improves employees’ skills (Hasanali 2003, 7−14).

Table 3.4 Data, information and knowledge continuum showing the smooth change in the process (adapted from Probst et al. 2000, 17, Managing knowledge : building blocks for success by PROBST, GILBERT ; RAUB, STEFFEN ; ROMHARDT, KAI. Reproduced with permission of JOHN WILEY & SONS, INCORPORATED in the format Other Published Product via Copyright Clearance Center).

Data	**Information**	**Knowledge**
Unstructured ……		.....Structured
Isolated ….		……Embedded
Context-independent ……		...Context-dependent
Low behavioural control …….		.....High behavioural control
Symbols ……		..Cognitive patterns for action
Distinction ……		……Mastery/capacity

Knowledge is accumulated, organised, integrated and held over longer periods to be available for handling specific sets of circumstances. Information consists of facts and data that are organised to describe a particular situation or problem. Knowledge is subsequently applied to interpret the available information about a particular situation and to decide how to handle it (Karl Wiig (1996) cited by Brooking (1996, 143)). Frigo (2006, 83) makes a simple distinction between information and knowledge as follows: ‘information is data or facts; knowledge is capacity to make effective decisions”. A similar definition, ‘capability (potential or actual) to take effective action’ is given to knowledge by Bennet and Bennet (2011). Information transforms into knowledge when it is used effectively in a situation or event. The prerequisite is that there also exists other information in that situation or event where information association can take place. With this association, knowledge is created and the right actions can be taken (Bennet and Bennet 2011, 1). Action and built-in experiences are criteria that Leonard et al. (2015) have attached to knowledge. Their definition of

knowledge is, ‘Information that is relevant, actionable and at least based on experiences’ (Leonard et al. 2015, 18).

One way to classify knowledge is to divide it into explicit, implicit or tacit. Explicit knowledge is available, fully defined, explained, formal, codified, and formalised in our heads, or embedded or documented in books, papers, technical reports, operating manuals, formulas, project reports, contracts, process diagrams and maps, lists of lessons learned, case studies, white papers, policies, procedures, checklists, job descriptions, work flows, databases, web contents or emails (Allee 2003, 99; Brooking 1996, 51; Davenport and Prusak 2000, 95−96; Hasanali et al. 2003, 16−17; Baker et al. 2004, 3; Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee 2011, 44; Tryon 2012, 34; Leonard et al. 2015, 19). Implicit knowledge is hidden in operating procedures, methods or corporate culture, but not formally documented. Novices find it difficult to learn implicit knowledge because of its covert character. Implicit knowledge is originally tacit knowledge, but it can be made explicit (Brooking 1996, 52; Tryon 2012, 35; Leonard et al. 2015, 19−21).

If awareness of others knowledge and individuals’ self-awareness of the knowledge is taken into account, knowledge may be divided into four types, i.e. explicit, implicit, tacit and evident. This classification is given by Blankenship et al. (2008) in the research of strategies to help drinking water utilities ensure effective retention of knowledge. With the evident knowledge they meant knowledge that is ‘unknown to the individual but seen by others’ (Blankenship et al. (2008, 2−3).

Choo (1998) divided organisational knowledge into tacit knowledge, rule-based knowledge, and cultural knowledge. Forms, examples and uses of this knowledge are shown in Table 3.5.

Table 3.5 Organisational knowledge (adapted from Choo 1998, 11, Management for the intelligent organization: the art of scanning the environment, an ASIS monograph published by Information Today Inc.).

Type	**Form**	**Examples**	**Use**
Tacit knowledge	Procedural Embedded in action	Know-how Heuristics Intuitions	Ensures task effectiveness, stimulates creativity
Rule-based knowledge	Declarative Encoded in programmes	Routines Standard operating procedures Record structures	Promotes efficiency, co-ordination, control
Cultural knowledge	Contextual Expressed in discourse	Stories/metaphors Mindsets/worldviews Visions/scenarios	Assigns significance to new information and knowledge

Rule-based knowledge is used in designing routines, standard operating procedures, and the structure of data records. Rule-based knowledge provides the formal structures for organisations, thus ensuring a high level of operational efficiency, co-ordination, and control while also creating a

framework for organisational learning. Cultural knowledge is communicated orally and verbally through stories, metaphors, analogies, visions, and mission statements (Choo 1998, 11−12).

Experiences, intuition and contextual information are brought up by Baker et al. (2004). Their practical definition of knowledge is as follows: 'Knowledge is a fluid mix of framed experiences, values, contextual information, expert insight and grounded intuition that provides an environment and framework for evaluating and incorporating new experiences and information' (Baker et al. 2004, 3).

In a study on knowledge retention, Liebowitz (2009, 73−78) presents the concept of harvesting knowledge, which elicits information on four types of knowledge. Table 3.6 shows links between information and knowledge.

Table 3.6 Knowledge and information in knowledge harvesting (adapted from Liebowitz 2009, 78, reproduced with permission of Auerbach Publications in the format Thesis/Dissertation via Copyright Clearance Center).

Type of knowledge	Information harvested	Value, use
Contextual knowledge	Signals	Knowing when, knowing why
Declarative knowledge	Support information	Knowing about
Procedural knowledge	Guidance	Knowing what and how to
Social knowledge	Collaborative norm	Knowing how to work with others

The beneficial characteristics of knowledge management are noted by Tryon (2012), who suggests that implicit and tacit knowledge are intellectual assets. When knowledge is shared, there is no loss to the original source. The value of knowledge increases when shared, and knowledge can be shared endlessly (Tryon 2012, 37−38).

This section has demonstrated the variety of general interpretations and characteristics of information and knowledge. It is now necessary to look deeper into tacit knowledge, which is a challenge to organisations.

3.2.2 Interpretations of tacit knowledge

Tacit knowledge is the most valuable asset an organisation possesses. Lubit (2001, 164−166) says that *sustainable competitive advantage* can only be developed by capturing and transferring tacit knowledge. Tacit knowledge is internalised in organisations, embedded in the firm culture and their people, routines and processes, and is thus not readily or easily available or transferable throughout the whole organisation. There are several definitions for tacit knowledge, which share the same elements. The existence of tacit knowledge has been known for a long time, but since the beginning of the 1990s, it has gained increasing attention and is now also considered in organisational strategies.

Polanyi wrote *Personal knowledge* in 1958 and *The tacit dimension* in 1966. His well-known definition for tacit knowledge is, 'We can know more than we can tell'. Polanyi (1966) states that tacit knowledge, skills and knowledge are something we do unconsciously − we are not aware of their existence. There is no way of making all tacit knowledge explicit, nor is there any need.

Regarding tacit knowledge, Choo (1998, 11−12) claims that it 'consists of the hands-on skills, special know-how, heuristics, intuitions, and the like that people develop as they immerse in the flow of their work activities. Tacit knowledge is deeply rooted in action and comes from simultaneous engagement of mind and body in task performance'. Similar approach is given by Haldin-Herrgard 2000, 358−359), who said that tacit knowledge is obtained by experience and reflection, and 'it has to be internalised in the human body and soul'. Also Ståhle and Grönroos (2000, 105−107) emphasise people's hidden knowledge based on *experience*. They equate experience with feelings and know-how, and conclude that people cannot express their actions in the form of logical explanations. Because forms of knowledge other than explicit make up 95 percent of all knowledge, tacit knowledge can only be transferred from one person to another by doing and talking.

Boiral (2002) studied the tacit knowledge related to environmental issues in Canadian industrial companies. He states that tacit knowledge 'is integrated in routines, behaviours and assimilates experiences' and 'is difficult to observe directly and measure quantitatively'. Boiral (2002, 298) defines tacit knowledge based on Polanyi's pragmatic approach as 'know-how based on observations, routines and work experience, which helps to improve environmental management, but whose empirical, context-specific and personal nature does not easily lend itself to formal explanations'.

Allee (2003, 96−99) says that in common usage, tacit knowledge means tacit knowledge in people's heads, and that codified and communicated tacit knowledge turns into explicit knowledge. Allee also states that tacit or unspoken knowledge should be extracted, codified, and shared with others. Hasanali et al. (2003, 16) describe tacit knowledge as 'hard to catalog, highly experiential, difficult to document in detail, and transitory. It is also the basis for judgement and informed action'. Similarly, Blankenship et al. (2008) use the definition, 'Tacit knowledge refers to unwritten and uncodified knowledge that resides in the heads of the knowledge workers, commonly thought of as "know-how". A person may not even be aware of this tacit knowledge until faced with a specific situation or problem'. However, tacit knowledge can in some cases be made explicit, but in the documentation sense, repositories only show who has the critical knowledge and experience (Blankenship et al. 2008, 2). Talking about water demands management practitioner's tacit knowledge Wolfe (2009) also shares the unawareness side of tacit knowledge and explains tacit knowledge as when people's 'deepest beliefs and values operate as a kind of implicit and unquestioned background understanding that shapes the way they see the world and act within it' (Wolfe 2009, 490).

According to Dalkir (2011, 10) 'property of tacitness is a property of the knower'. By this, she means that some people can easily articulate contents, but for some people it is hard to externalise, i.e. 'the

same content may be explicit for one person and tacit for another'. Dalkir compares the properties of tacit and explicit knowledge as shown in Table 3.7.

Table 3.7 Properties of tacit knowledge and explicit knowledge (adapted from Dalkir 2011, 10, reproduced with permission from The MIT Press).

Properties of tacit knowledge	**Properties of explicit knowledge**
Ability to adapt, to deal with new and exceptional situations.	Ability to disseminate, to produce, to access and re-apply throughout the organization.
Expertise, know-how, know-why, and care-why.	Ability to teach, to train.
Ability to collaborate, to share a vision, to transmit a culture.	Ability to organize, to systematize, to translate vision into a mission statement, into operational guidelines.
Coaching and mentoring to transfer experiential knowledge on a one-to-one, face-to-face basis.	Transfer knowledge via products, services, and documented processes.

When comparing the experts and novices, Health notes that novices may not need the knowledge of what experienced employees know. Instead, they have to figure out tacit knowledge, i.e. what experts think and feel, how they respond and react (Health 2003, 185−186). According to Dalkir skilled and experienced experts have difficulties in articulating their know-how, while novices can explain what they do because they follow manuals or how-to processes (Dalkir 2011, 10).

Geldof et al. (2011, 3) focus on tacit knowledge as a crucial resource in complex and unpredictable water issues and approach the characteristics of tacit knowledge from the view of experienced employees as follows: 'the scope and depth of their interpretations, their ability to sense weak signals of the new, in their ability to distil significance from the details, in the choices skilled people make when dealing with especially those problems or developments that exceed the boundaries of routine and well known issues, and their ability to learn from the unexpected'.

Tacit and explicit knowledge complement each other. Boiral's (2002) example of an environmental problem solution highlights the fact that, while engineers' solutions are often complex, operators' solutions are based on tacit experience of the process and are, thus, context-specific and simple. This is know-how, which refers to the knowledge individuals possess about a particular topic (Brooking 1996, 41).

CEN (2004c) defines good practices in knowledge management for small and medium-sized enterprises. The definition for tacit knowledge is as follows (CEN 2004c, 12): 'Tacit knowledge (sometimes also called implicit knowledge) consists of mental models, behaviours and perspectives, largely based *on experiences*. This knowledge is difficult to codify, but knowledge management techniques such as learning-by-doing or collaboration between communities can help people to share this knowledge'.

Different definitions of tacit knowledge share individuality, and point out how difficult it is to express and share. Baker et al. (2004) use the term '*soft knowledge*' when speaking about tacit knowledge. They emphasise the nature of tacit knowledge as 'personal, context-specific knowledge that is difficult to formalize, record, or articulate' (Baker et al. 2004, 3). Brooking (1996, 51) assigns the term *special ability* to people rich in tacit knowledge. The only way those people can explain their ability is: 'Well, I just know'. Leonard and Swap (2004, 88–90) refer to people whose judgement and explicit and tacit knowledge are stored in their heads and hands as people having *deep smarts*. These assets can only be neglected at an organisation's own peril. If these people leave the organisation, their practical, organisation-specific expertise gathered over many years goes with them (Leonard and Swap 2004, 90). On the other hand, it is risky to rely totally on personal tacit knowledge in organisations. Making tacit knowledge explicit or sharing it with others offers greater value to the organisation as stated by Haldin-Herrgard (2000, 357).

Linde (2001) presents a simplified taxonomy of types of tacit knowledge (Figure 3.2). The focus of her *taxonomy* is social knowledge, which can be divided into individual and group knowledge. The tacit knowledge component of individual knowledge consists of language, individual identity, membership practice, and work practice. Group knowledge is made up of work practice, identity practice, and membership practice.

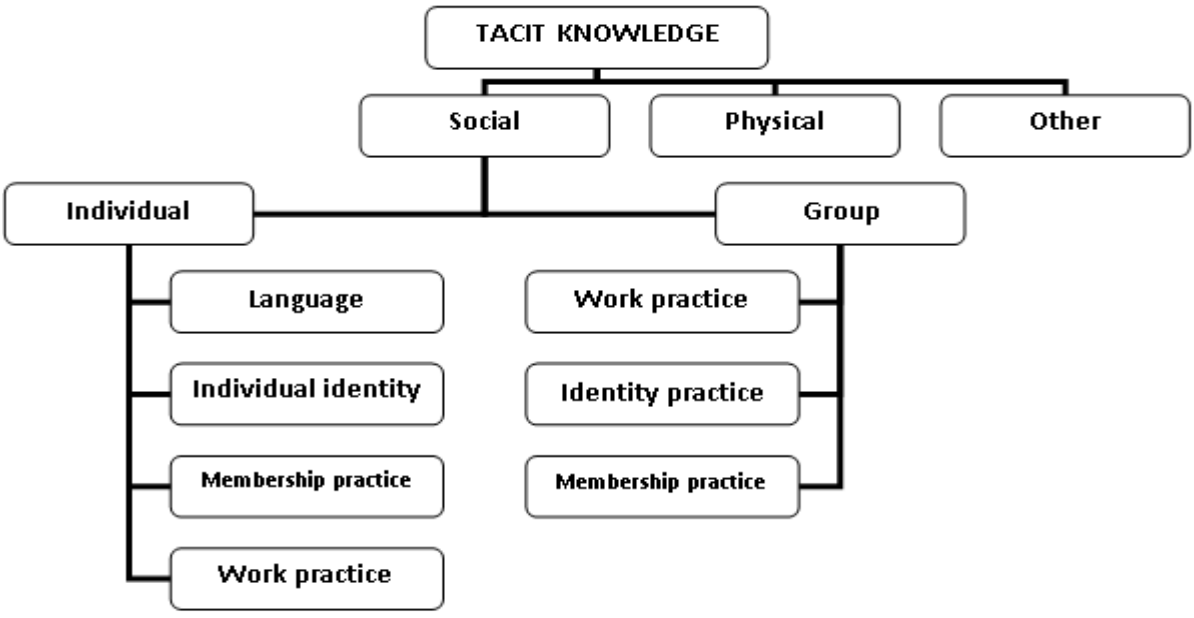

Figure 3.2 Types of tacit knowledge (adapted from Linde 2001, 161).

As a phenomenon, tacit knowledge has been studied much in relation to organisations and working environments. Haldin-Herrgard (2000, 358), citing Gore and Gore (1999), say that 'epitomes of tacit knowledge such as intuition, rule-of-thumb, gut feeling and personal skills' can be classified into technical and cognitive dimensions. Information and expertise are technical, while mental models, beliefs and values are cognitive. Haldin-Herrgard (2000, 358) add that action is needed to make tacit knowledge understood, which means that technical formulas have to be ignored. This description has similarities with Lubits' (2001) tacit knowledge categories.

Lubit (2001) classifies tacit knowledge into four categories: knowledge know-how, mental models, ways of approaching problems, and organisational routines. With know-how (or as Lubit expresses it, 'hard to pin down skills') he means that organisation members should continuously practise their skills and receive feedback. That way they can really feel the skills. Mental models or schema structure the world – its elements, and their relations. Mental models help scan the relevant data from the environment and solve problems. The third category relates to how people approach problems. The habits and mental patterns created during earlier problem solving instances have led to the construction of internal decision trees, which are used when new problems are faced. By organisational routines, Lubit (2001) refers to regular and predictable behaviour patterns. Tacit knowledge is deeply rooted in an organisations routines, which solidify standard operating procedures and develop and endorse rules (Lubit 2001, 166−167). Operating information contains a significant amount of tacit knowledge, which is in a danger of being lost when employee leaves the employer. On the other hand, operational information and tacit knowledge embedded in it needs to be up-dated by capturing knowledge and making knowledge available (Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011, 44−45).

3.2.3 Critical knowledge

According to Liebowitz (2009, 7−9) critical knowledge is the knowledge, which is vital for the organisation, to its strategic mission and core competencies. Tryon (2012, 53) pointed out that if critical knowledge is lost 'it will cause devastating implications to the organization including lost capabilities or complete failure'. Tacit knowledge which only a few employees have is critical, too. Thus, critical knowledge should be captured, retained and transferred in the organisation (Tryon 2012, 53−54).

O'Berry (2007,44) emphasises the fact that the livelihood of a water utility depends on critical knowledge. Therefore, it is extremely important for the management to know who has knowledge and what kind of knowledge they have. Yet, Blankenship and Brueck (2008, 59) state that the most critical knowledge cannot be written down, neither can it be learned by reading someone's notes.

Critical knowledge is at risk of disappearing, if it is not properly captured before retirement or other reasons employees leave an organisation. Post and Breen (2005, 45) use the words, '*inherent expertise*' and '*work legacy*', to emphasise the centuries of experience and hands on know-how of processes, equipment, and systems that leaving employees possess. This knowledge is

undocumented, but crucial to any water utility. According to Post and Breen (2005, 46) the widest knowledge gap occurs in engineering, skilled crafts and trades, and technical expertise. When the complexity of water systems increases and technological advances expand, knowledge gaps can be severe.

According to Frigo (2006) knowledge about water utilities can be divided into three types of knowledge: technical, social, and structural knowledge. Critical knowledge is operational knowledge, which is at the greatest risk of being lost. Individual capabilities and skills are technical knowledge, while relationships and working cultures are social knowledge. Structural knowledge is embedded in the organisation, its systems, processes, policies, and procedures. Explicit and rule-based knowledge is typical of structural knowledge (Frigo 2006, 83).

Frigo (2006, 83) gave the following examples of knowledge, which also could be critical knowledge:

- *technical knowledge: 'the ability to operate a particular pump, the ability to use spreadsheet software, and an understanding of chemical reactions'*
- *social knowledge: 'an ability to communicate effectively with local politicians, and to function well within a utility's unique working culture'*
- *structural knowledge: 'knowledge of how to follow the utility's procurement process, to purchase a piece of equipment, and to navigate a permit process'.*

3.2.4 Scope of knowledge management

Knowledge management should be seen in a wide context. It is not a separate system but deeply linked to the whole organisation and its environment. Probst et al. (2000, 14) describe organisational knowledge base as a key element in managing knowledge as a resource (Figure 3.3). Similarly, Grigg and Zenzen (2009, 110) view knowledge management as supporting learning in organisations, where people, processes and procedures constitute a uniform entirety. If knowledge resources are manageable, all the concepts related to knowledge should be clearly understood. However, the problem of what organisations know, and what they do not know still exists (Heath 2003, 185), see Sub-chapters 3.2.1 and 3.2.2.

The American Productivity and Quality Center (APQC 2016) has determined knowledge management to be 'a collection of systematic approaches to help information and knowledge flow to and between the right people at the right time (in the right format at the right cost) so they can act more efficiently and effectively to create value for the organization'. The European Committee for Standardization's (CEN) Workshop Agreement (CEN 2004c, 12) states that knowledge management is the 'planned and ongoing management of activities and processes for leveraging knowledge to enhance competitiveness through better use and creation of individual and collective knowledge resources'.

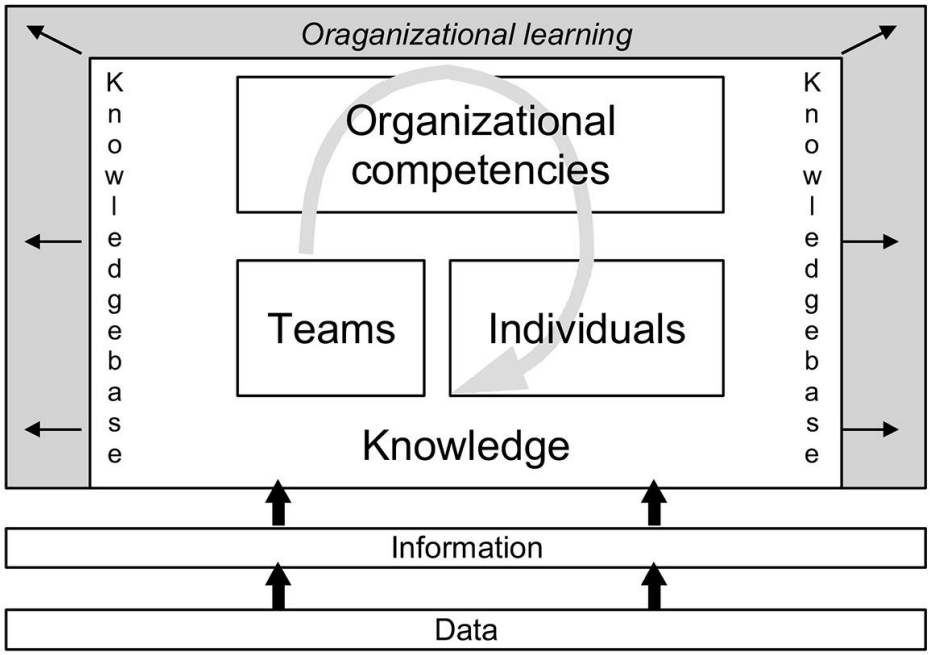

Figure 3.3 Organisational knowledge base (adapted from Probst et al. 2000, 14, Managing knowledge : building blocks for success by PROBST, GILBERT ; RAUB, STEFFEN ; ROMHARDT, KAI. Reproduced with permission of JOHN WILEY & SONS, INCORPORATED in the format Other Published Product via Copyright Clearance Center).

There are also complex definitions of knowledge management, like that by Smigiel et al. (2006, cited by Grigg (2006, 96): 'business strategy by which a water utility consciously identifies, captures, indexes, manages, and stores experiences, data, information, and provides methods for easily accessing and acting these collective assets (corporate history) in a collaborative environment (learning culture) optimizing the use of (leveraging) people, processes, and technology in support of effective decision making, assuring compliance, improving performance, innovation, and business continuity, all on a timely and sustainable basis'.

Awad and Ghaziri (2004) write that knowledge management is 'the process of capturing and making use of a firm's collective expertise anywhere in the business'. Their concept has two components, the recorded and stored explicit knowledge, and the tacit knowledge found in people's heads. Knowledge management consists of three overlapping components: people, by which they mean the workforce, technology, by which they mean the information technology infrastructure, and organisational processes (Awad and Ghaziri 2004, 2−7).

CEN (2004c) define knowledge management as follows: 'Planned and ongoing management of activities and processes for leveraging knowledge to enhance competitiveness through better use and creation of individual and collective knowledge resources'. Figure 3.4 shows the European

perspective on the framework of knowledge management. Similar thoughts are shared by Pablos-Mendez (2003, 2) who gives the following working definition for knowledge management: 'The optimisation and functional integration of the production, translation, dissemination and utilisation of knowledge for problem-solving and organisational effectiveness'. Dalkir (2011, 184) shares views on efficiency and effectiveness by stating the objectives: 'knowledge reuse to promote efficiency and innovation to introduce more effective ways of doing things'.

Figure 3.4 The European perspective on knowledge management framework integrates processes, activities and enablers (adapted from CEN 2004a, 7, © CEN, reproduced with permission).

Knowledge management was understood at the World Health Organisation in 2005 as 'a set of principles, tools and practices that enable people to create, share and apply what they know – to improve effectiveness and create value' (WHO 2005). In 2016, the knowledge management definition was described as 'how the secretariat uses technology to enable people to create, capture, store, retrieve, use and share knowledge' (WHO 2016). The focus has shifted towards utilisation of technology-driven solutions.

At the World Bank, knowledge management has gained a lot of attention since 1996, when a knowledge bank and knowledge networks were launched. In 2002, the World Bank established a 'pillars of knowledge' strategy where knowledge sharing plays an important role: 'focus is on adopting, adapting, and applying knowledge in a way that helps World Bank personnel, clients, and partners work more effectively to reduce global poverty'. Over the years, the focus on knowledge issues had widened and the target of knowledge management has become more integrated solutions. Knowledge sharing appeared in the focus areas in 2000, building knowledge networks in 2004, using knowledge to improve develop effectiveness in 2008, knowledge strategy and access to information in 2010 and knowledge services with knowledge platforms in 2011. Access to

information policy was revised in 2015. Innovative knowledge services will be developed towards knowledge sharing among clients and public (World Bank 2005, World Bank 2011, x−xi, World Bank 2015, 10).

The Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee's focus is on organisational knowledge: identifying key knowledge, capturing, storing, retrieving and the dissemination of it. The committee also addresses the role of public organisations, citizens and policy makers in the knowledge management of the water sector. Their definition for the purpose of knowledge management is: 'to meet the information needs of current and future employees as well as the managers, public officials, and citizens who need to understand both what is occurring and what has occurred in order to make responsible decisions at the policy level' (Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee 2016, 45−46).

Grigg's (2006, 96) definition of knowledge management, 'a process that's makes important information and experience available for utility employees to use in their job', is quite simple and easy to pass to water utility employees. Bennet and Bennet (2011, 3) formulate the knowledge management definition with resonating the needs of each water utility by saying, 'knowledge management can be considered a business strategy to improve organizational performance through the creation, sharing, leveraging and application of the organizations' knowledge in its day-to-day operations'. They also have another definition: 'Knowledge management is the systematic process of creating, maintaining, and nurturing an organization to make the best use of knowledge to achieve: (a) efficiency in operations; (b) effectiveness of operations; (c) quality of products; (d) sustainable high performance'. They further emphasise that the employees are key actors in knowledge management issues, i.e. doing things right and doing right things (Bennet and Bennet 2011, 3−4).

R.K. Price (2001) says that, in the water sector, knowledge management provides 'a rationale for better management of knowledge, regarded increasingly as a collection of objects rather than something to be known by the knower'. His definition of organisational knowledge management includes needs, acquisition, application, dissemination and sharing of knowledge, interaction with changes in society, information and communications technologies used in knowledge management, and individual and organisational learning. R.K. Price (2001) also discusses organisations' awareness of knowledge and management of knowledge assets. His example comes from water utilities and their asset management. Although water utilities have significant underground and structural assets, they do not have enough knowledge of those assets. This is alarming because utilities' ability to provide good services to customers economically depends on proper utilisation and maintenance of all assets (Price R.K. 2001, 1−7).

When discussing workforce issues, the Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011, 45) defines the goal of knowledge management as to 'ensure that the right people have the right skills at the right time to perform the work needed'. Their

definition comprises people, processes and technologies. Quite similar content regarding knowledge management is given by the Water Research Foundation (2011,3): 'the systematic process of creating, maintaining and nurturing an organisation to make the best use of knowledge to achieve: (a) efficiency of operations; (b) effectiveness of operations; (c) quality of products; and (d) sustainable high performance'. They also use a more formal definition: 'business strategy to improve organizational performance through the creation, sharing, leveraging and application of the organization's knowledge in its day-to-day operations' (Water Research Foundation 2011, 3).

Although knowledge management has been considered something that can solve all problems, it has also been criticised. For example, Heath (2003) and Awad and Ghaziri (2004) suggest that managing knowledge is not the issue. Rather, it a question of managing individually controlled, personal, and autonomous knowledge (Awad and Ghaziri 2004, 7) or establishing infrastructures – policy, technical, managerial and cultural – that enable knowledge creation, sharing and usage (Heath 2003, 184).

3.2.5 Phases of knowledge management

Many knowledge management models have been created. The approaches can emphasise various phases and elements from knowledge (either explicit or tacit) sharing and generation to knowledge strategy and knowledge retention. A common feature of knowledge management models is the cycle structure. Some approaches will be explained in this section.

According to Probst et al. (2000, 29−34), the elements of knowledge management are identification, acquisition, development, sharing or distribution, utilisation, retention, assessment and goals (Figure 3.5). The first five elements form the core process of knowledge management but do not have to be treated in logical order. This means that findings of any process may affect other processes.

Based on several knowledge management cycle models, Dalkir (2011, 51−56) created an integrated knowledge management cycle (Figure 3.6). Dalkir's cycle consists of three stages: knowledge capture and/or creation, knowledge sharing and dissemination, and knowledge acquisition and application. Knowledge capture includes identification and codification of an existing organisation's knowledge of know-how from the internal or external environment. The value of the outcome, created new knowledge or know-how, is assessed, and valuable knowledge stored and shared. The next phase is contextualisation, when content is made available for end users, i.e. embedded in the organisation's processes. Then, knowledge is used and validated, which finally leads to updated content and new iteration (Dalkir 2011, 53−54).

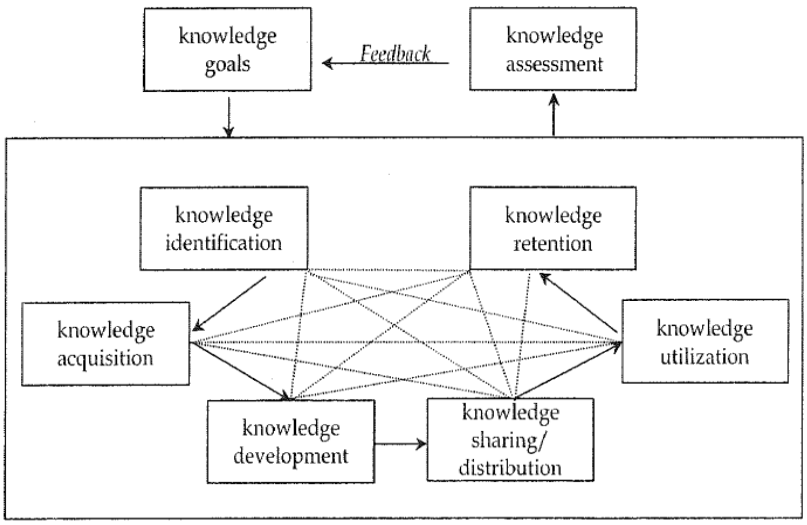

Figure 3.5 Eight elements of knowledge management and their interrelationships (adapted from Probst et al. 2000, 30, Managing knowledge : building blocks for success by PROBST, GILBERT ; RAUB, STEFFEN ; ROMHARDT, KAI. Reproduced with permission of JOHN WILEY & SONS, INCORPORATED in the format Other Published Product via Copyright Clearance Center).

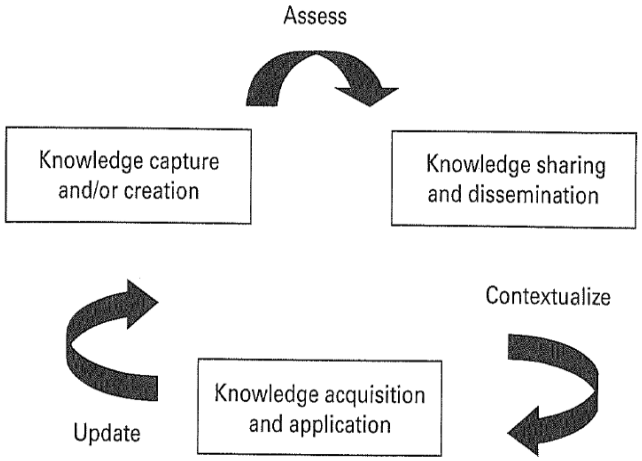

Figure 3.6 Integrated knowledge management cycle (adapted from Dalkir 2011, 54, reproduced with permission from The MIT Press).

Nonaka and Takeuchi (1995, 61−73) developed a so-called SECI model for the creation of knowledge. Their model is based on Polanyi's distinction between explicit and tacit knowledge. The model comprises four dynamically interacting processes: socialisation, externalisation, combination, and internalisation. The movement through the four modes of knowledge forms an interactive spiral between tacit and explicit knowledge (Figure 3.7).

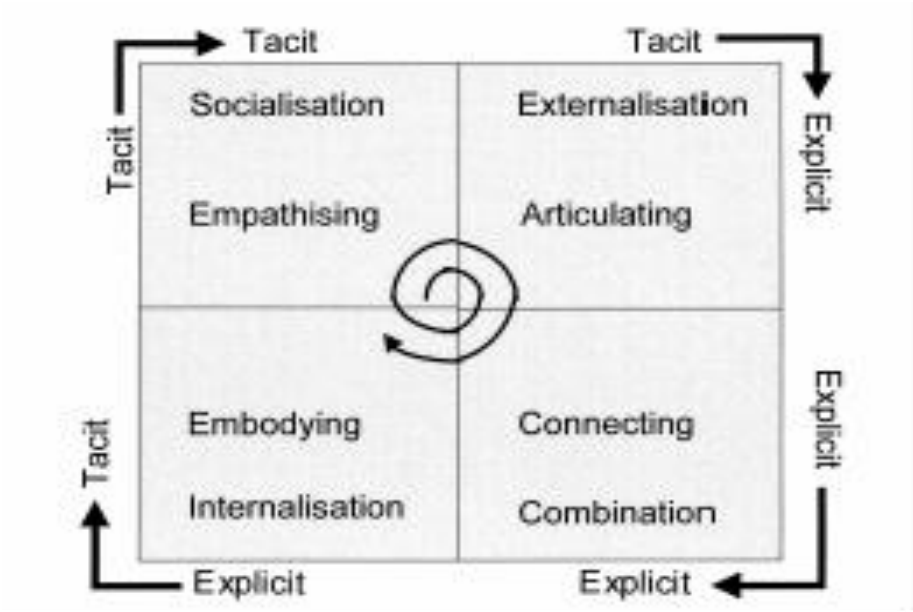

Figure 3.7 SECI (Socialisation, Externalisation, Combination, and Internalisation) model (adapted from Nonaka et al. 2000, 12)

In socialisation, new tacit knowledge is formed through shared experiences, like spending time together, living in the same environment, apprenticeship, and informal social meetings within and outside the organisation. In externalisation, tacit knowledge is made explicit. This happens, for example, in product development or when utilising employees' tacit knowledge for process improvements. Explicit knowledge is converted into more complex explicit knowledge through a combination process. In this process, explicit knowledge collected from, within or outside of the organisation is converted into new knowledge and shared with other members of the organisation. In the final mode, internalisation, explicit knowledge is shared in the organisation and converted into new tacit knowledge. *Learning-by-doing* describes internalisation quite well. Internalisation takes place, for example, during training events, document reading, simulations or experiments (Nonaka and Takeuchi 1995, 61−73; Nonaka et al. 2000, 8−13).

Miles' (2003) report discusses knowledge management in knowledge-intensive services. The model used in that report is based on Nonaka's model, which Dawson reworked. The basic distinction is in the terminology, where 'explicit' and 'tacit knowledge' have been replaced by 'knowledge' and 'information' (Miles 2003, 45). Table 3.8 shows a selection of the SECI modes.

Table 3.8 Different contents of SECI (Socialisation, Externalisation, Combination, and Internalisation) modes.

SOCIALISATION	**EXTERNALISATION**
Shared mental models and technical skills; Sympathised knowledge: from tacit to tacit knowledge (Nonaka and Takeuchi 1995)	Metaphors, analogies, concepts, hypothesis, or models; conceptual knowledge: from tacit to explicit knowledge (Nonaka and Takeuchi 1995)
Empathising (Nonaka et al. 2000)	Articulating (Nonaka et al. 2000)
Sharing experiences, observing, imitating, brainstorming without criticism (Hildreth and Kimble 2002)	Writing it down, creating metaphors and analogies, modelling (Hildreth and Kimble 2002)
Sharing experiences to create shared mental models; learning through observation, imitation and practice; example: apprenticeship. (Adolph 2005)	Articulating tacit knowledge in explicit concepts; use of metaphors, analogies, hypotheses and models; concept creation through dialogue and collective reflection (Adolph 2005)
Transfer of knowledge between people (through interaction rather than mediated through captured information; knowledge to knowledge (Miles 2003)	Capturing people's knowledge by rendering it as documents or structured processes; knowledge to information (Miles 2003)
An informal community of social interaction shares experience and facilitates the co-creation of 'common perspectives', thereby contributing to the 'common good'; output is sympathised knowledge (Al-Jayyousi 2004)	Team articulates the perspective through continuous dialogue, whereby participants engage in the mutual co-development of ideas; output is conceptual knowledge (Al-Jayyousi 2004)
INTERNALISATION	**COMBINATION**
Learning-by-doing; documents, manuals, or oral stories; operational knowledge: from explicit to tacit knowledge (Nonaka and Takeuchi 1995)	Documents, meetings, telephone conversations, computerised communication networks, reconfiguration of existing information, formal education and training; systemic knowledge: from explicit to explicit knowledge (Nonaka and Takeuchi 1995)
Internalisation (Nonaka et al. 2000)	Connecting (Nonaka et al. 2000)
Access to codified knowledge, goal-based training (Hildreth and Kimble 2002)	Sorting, adding, categorising, methodology creation, best practices (Hildreth and Kimble 2002)
Embodying explicit knowledge into tacit knowledge; "learning-by-doing" to arrive at shared mental models; use of documents, manuals and oral stories (Adolph 2005)	Systemising concepts into a knowledge system; combining different bodies of explicit knowledge; use of media, including IT (Adolph 2005)
Knowledge acquisition – learning how to use models, formulae, equipment, methods, etc.; information to knowledge (Miles 2003)	Systematising and/or translating formalised concepts into new frameworks, procedures, etc.; information to information (Miles 2003)
Individuals internalise knowledge tacitly, through direct, hands-on experience; output is operational knowledge (Al-Jayyousi 2004)	Combination of different bodies of knowledge held by individuals through formal exchange mechanisms such as formal meetings, office memos and codes of conduct; output is systematic knowledge (Al-Jayyousi 2004)

Weggeman (IRC/WELL 2004) described in his knowledge management model the operational knowledge process phases (Table 3.9). This model, called the knowledge value chain, is used by the IRC. The starting point is the organisation's mission, vision and goal. There is then an establishment of what knowledge is needed and what is available. When the missing knowledge is developed, sharing of knowledge with the employees can start. Shared knowledge is used in the application phase. Application of shared knowledge is the most important part of the whole process. The last phase involves evaluation of the knowledge process. The process cycle loops back to the organisation's goal and core competences.

Table 3.9 Elements of the knowledge value chain by Weggeman (adapted from IRC/WELL 2004).

Mission/Vision	**Knowledge**			**Share**	**Apply**	**Evaluate**	
Goal(s)	**Needed**	**Available**	**Develop**	**Knowledge**			
Strategy							Do it
Culture							Hard
Personnel							Hard
Management style							Hard
Structure							Easy
Systems							$

The five core knowledge activities CEN uses are: identify, create, store, share, and use. Identification takes place both at the organisational and individual levels. Organisations should know what information is needed in strategic decision making, and individuals should determine what information and knowledge is needed in daily tasks. CEN places particular emphasis on creation, by which they mean new knowledge creation. This takes place at the individual and team level in social interaction, and at the organisational level in research and development work (CEN 2004a, 10).

The models of Probst et al. (2000), IRC/WELL (2004), and CEN (2004a) have similar elements, while the definition of knowledge need is clearly closer to the information sciences discipline. In the SECI model and Dalkir's cycle the emphasis is more on the creation of new knowledge, which fosters organisations' development.

The integrated model of knowledge strategy described by Grigg and Zenzen (2009, 113−114) combines knowledge creation, knowledge management systems, water utility employees and organisational work, as shown in Figure 3.8. According to Grigg (2006, 96), knowledge management systems must document, vet and organise tacit knowledge, including updating and improving features.

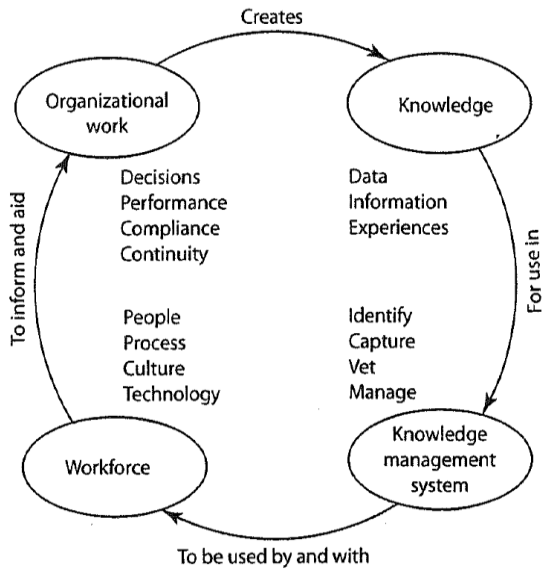

Figure 3.8 Integrated knowledge management strategy (Source: Grigg, N. & Zenzen, M., 2009. The Water Workforce: Strategies for Recruiting and Retaining High-Performance Employees. AWWA, Denver. Republished with permission).

3.3 Information and knowledge sharing and creation

3.3.1 Knowledge sharing principles

Polanyi's position is that tacit knowledge sharing underlies any *act of communication*, in the form of *unspoken commonalities* around very basic perceptions and human interaction. In his view, there is no linear progression of knowledge from tacit to explicit; they are two aspects of one process of knowing. Thus, when knowledge is shared, articulated or explicit communication and unspoken tacit communication happens at the same time (Polanyi 1966).

It is not, however, enough that organisations have knowledge. To be able to satisfy an organisation's and customers' needs and gain added value, knowledge has to be shared. Knowledge sharing happens through movements, body language, and any symbolic language such as words, mathematics, drawings, and stories (Allee 2003, 96−99). Emphasis has to be on the quality of knowledge and the timing and place of sharing it.

The sharing of knowledge is important also with the grey materials, i.e. written reports, manuals, working papers, etc. which do not enter into databases or other depository systems and are thus not easily accessible. The origin of the material may be tacit, which has been encoded into explicit knowledge (Price R.K. 2001, 2).

Tacit knowledge sharing practices have been described in several publications as discussed earlier in Sub-chapter 3.2.2. There are several ways to share and foster sharing of knowledge as shown in Table 3.10. Some of them are closely related to organisational culture and some to making knowledge visible by different means.

Table 3.10 Ways to share and foster sharing of knowledge (Brooking (1996, 96−129); Devlin (1999, 175−184); Lubit (2001, 173−176); Boiral (2002, 301−312); Stemke (2000) cited by Allee (2003, 94−96); The Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011, 47−49), Liebowitz (2009, 117−118); Heino et al. (2011, 11); Tryon 2012, 54−56).

Organisational and cultural actions	Development of a strong institutional knowledge-sharing culture Developing recruitment criteria Developing promotion criteria Open communication culture, which values openness, tolerates failures, encourages questioning and permits challenging Strong work values will facilitate tacit knowledge transfer and increase knowledge flows in edge organisations Motivation to seek, use and share knowledge through being recognised and rewarded will increase tacit knowledge transfer and increase knowledge flows in edge organisations Engagement of personnel in decision making, explaining decisions made, and clarifying expectations and rules in decision making Working groups or committees, which comprise all employee groups, provide places for dialogue Periodic, larger meetings are dedicated to show outstanding practices that are broadly applicable across the organisation
Tools and materials	Increasing the amount of available explicit knowledge by making implicit and tacit knowledge explicit Standards promote codification and retention of the most relevant knowledge – mainly concerning policy implementation, but partly also tacit Recording tacit knowledge by writing, video technology and studying learning histories and developing routines for situations Training materials and tools on knowledge capture and transfer Databases used for recording and sharing best practices Formal knowledge management systems used within a utility's intranets
Development of competence and skills	Built models can conceptualise working environment, and address problems, thus enhancing skill development Cross-enterprise teams learn new methods from other business units Managers travel around the world, visit sites, and learn best practices People networks share best practices in a specific area In communities of practice groups, people share an interest in an issue, discuss problems, brainstorm, and share knowledge Informal networks will result in an increase in tacit knowledge transfer and increased knowledge flows in edge organisations In-house training programmes, competency-based training to meet the needs of the job Formal apprenticeship programmes combine formal training in education units and on-the-job training Apprenticeships, where knowledge is shared between experienced employees and new employees Coaching and mentoring arrangements, opportunities to observe experts, responding to questions by others, sharing of tacit knowledge that is trial-and-error learning

3.3.2 Constraints in sharing knowledge

There are several possible organisational or individual reasons why knowledge is not necessarily shared in organisations. Difficulties in sharing knowledge can occur, for example, in relation to the aspects shown in Table 3.11.

Table 3.11 Constraints in sharing knowledge (Awad and Ghaziri 2004, 2−27, 260−264; Boiral 2002, 306−312; CEN 2004a, 12−14; Devlin 1999, 58−61; IRC 2004b; Haldin-Herrgard 2000, 361-363; Probst et al. 2000, 192−195; Prusak and Daveport 2000, 96−104; Lubit 2001, 172−173; Baker et al. 2004, 5; Wilson 2009, 46−54; Visscher et al. 2006, 30−33; Liebowitz 2009, 117−118; Blankenship et al. 2008, 8-10; Liebowitz 2012, 8−9; Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee 2011, 50; Bennet and Bennet 2011, 38−42; Dalkir 2011, 168−169; Leonard et al. 2015, 182−199).

Organisational characteristics and barriers	**Individual characteristics and barriers**	**Cultural characteristics and barriers**
Hierarchical structures	Individual's personality, talents and social behaviour	Organisational culture
Functional structures	Willingness to share	Power distance
Organisational strategies, initiatives and policies	Resistance to change	Value of knowledge
Management and leadership practices	Attitude	Atmosphere of trust and respects
Financial constraints	Lack of training	Language
Lack of up-to-date information	Perception (personal knowledge)	Work norms
Convenient knowledge management infrastructures, new technologies and devices (incl. wiki, mobile devices, video technology)	Lack of ability to use communication channels and social media applications	Vocational reinforcers: compensation, recognition, ability utilisation, creativity, good work environment, autonomy, job security, moral values, advancement, variety, achievement, independence, social status
Manpower and knowledge drain; workers leaving the company	Lack of time	Different generations

Knowledge sharing needs organisational and technical infrastructures, but these only constitute a part of the sharing environment. Infrastructures combined with individual and cultural issues form the basis for knowledge sharing. If the hierarchical and functional barriers conflict with each other, the result might be a splintery organisational knowledge base. It is also called disconnected islands of knowledge, which implies that the knowledge is scattered in small pieces all over the organisation, and these pieces are not linked together (Probst et al.2000, 192−193). Similarly, Visscher et al. (2006, 32) emphasise that in organisations with several departments and teams, knowledge is

shared within the staff's own department or team, but not necessarily between other departments or teams.

Perception refers to awareness of people's knowledge. Haldin-Herrgard (2000, 361) writes that every employer can recognise the explicit knowledge people possess, but they cannot see the missing links or intuition-based elements, i.e. tacit knowledge. How employees behave and think is internalised in their routines. Knowledge, whether explicit or tacit, is important for personnel in performing given tasks, and it is even better if it fulfils individual objectives simultaneously (CEN 2004a, 14).

Language itself is a problem in sharing knowledge. In situations where the employees do not speak the same language – either they do not share the same mother tongue or they come from different disciplines (for example, engineering vs. health care) – many problems can arise. Haldin-Herrgard (2000, 361) and Linde (2001, 161−162) discuss tacit knowledge and non-verbal forms of language. People have problems in expressing themselves or they cannot articulate natural, obvious and routine things or the rules related to the use of language. Sometimes people are not conscious of what they really know tacitly. The more experiences personnel have, and the more tacit knowledge is rooted into the practices, the harder it is to dig it out from the employees' heads. One case that Haldin-Herrgard (2000, 361) raises up is the expert-novice relationship during training, and especially the expert's ability to express tacit knowledge. If the expert cannot express himself/herself, sharing of knowledge does not happen. Of course, having or not having a common language plays an important role, too. Terminological diversities and jargons prevail among different business sectors and among different occupational groups. But jargon can also be a source of externalised tacit knowledge. For example, customers with certain characteristics might be renamed, and the nicknames may have a tacit component (Haldin-Herrgard 2000, 361).

Probst et al. (2000), CEN (2004a) and Bennet and Bennet (2011) agree that the barriers to sharing knowledge at the individual level are either related to the individual's ability or willingness to share it. How communicative and social the individual is greatly determines knowledge sharing. CEN (2004b) suggests special schemes, like awards, promotions, and acknowledgement, to be used to induce appropriate knowledge behaviour. Liebowitz (2009, 5) suggests that human resources departments of organisations should develop means to recognise or reward those who share their knowledge. In addition, Visscher et al. (2006, 32) discuss setting incentives, such as clarifying the importance and benefits of knowledge management, sharing successful cases, and easy access to knowledge sources, with personnel to help them adhere to the knowledge management policy of the organisation.

Daily tasks are often carried out under hectic and turbulent conditions, and information overload may be real or imagined. There is not enough time to manage knowledge or make any additional efforts for sharing it. The scarcity of time leads to situations where experiences will not be documented or reflected. Therefore, tacit knowledge remains elusive (CEN 2004a, 14; Haldin-Herrgard 2000,

361−362; Probst et al. 2000, 171−178; Bennet and Bennet 2011, 37). Time is the most significant obstacle to sharing critical, experience-based knowledge, as expressed in the research on top executives of companies conducted by Leonard et al. (2015). After time, other significant obstacles include experts who are reluctant to share, geographic dispersion and limitations of recipients. The lastly mentioned obstacle is rather interesting, because it deals with newly hired personnel. Younger employees may be unable or unwilling to learn from older workers. The knowledge gap between younger and older employees may be too wide if the newcomer lacks foundational knowledge. As for unwillingness of the expert to share, there can be a question of motivation or generational differences. Younger personnel might have too much self-confident, they might misunderstand older employees, or they simply might not appreciate the experience (Leonard et al. 2015, 186−199).

The adequacy of time also affects management and organisational issues. If it has been made clear to employees why time has to be allocated for managing knowledge and documenting lessons learned, they are more co-operative. The organisation's management should emphasise how important this task is. The personnel will benefit in one way or another. Lessons learned may be helpful for individual persons in their daily tasks and for the organisation as a whole (CEN 2004a, 14).

Organisations have always appreciated and valued formal education. Today, organisations also understand other aspects, which may be of greater value to them than formal training or craftsmanship. A trendy phenomenon seems to be to focus on tacit knowledge, and how to capture it. The problem lies in the measurement: how and by what parameters should tacit knowledge be measured? In 2000 Haldin-Herrgard (2000, 357) reported that intangible things like tacit knowledge were still rather unusual things to be appreciated. In 2014, the role of tacit knowledge was increasingly seen as critical for the organisation's survival.

The physical distance between employees may be one hindrance to knowledge sharing. If the organisation has offices or subsidiaries all over the world, or the distance between units is long, occasions for face-to-face discussions will be scarce. This in turn reduces sharing of tacit knowledge. Explicit knowledge can be shared by different knowledge management applications, but tacit knowledge is hard to diffuse technologically (Haldin-Herrgard 2000, 363). Boiral (2002, 304−306) gives an example showing how the physical proximity of workers to the processes affects their knowledge development; when workers came into direct contact with equipment, they developed implicit knowledge of sources of contaminants.

O'Berry (2007) states that formal organisational charts do not necessarily indicate the sharing path of knowledge. In most cases knowledge is shared along relationships between employees (O'Berry 2007, 44). Successful cross-generational knowledge flows are discussed by Liebowitz (2012, 8), who stresses that critical success of knowledge flows depends on shared values, reciprocity, intrinsic worth of knowledge, convenient transfer mechanisms, interpersonal trust and respect.

Awad and Ghaziri (2004, 95) suggest that ‘people who are extroverts, display self-confidence, and feel secure tend to share experiences more readily that those who are introspective, self-centered, or security conscious’. They continue, ‘people with a positive attitude, who trust others, and who work in an environment conducive to knowledge sharing tend to be better at sharing than those working in a cut-throat environment’. Awad and Ghaziri (2004, 95) use the term *vocational reinforcers*, which they regard as the keys to knowledge sharing: ’People whose vocational needs are met by job reinforcers are more likely to favour knowledge sharing than those who are deprived of one or more reinforcers’.

Willingness to share knowledge depends on many factors. Some of them are related to the personnel’s attitudes about sharing, and some to the pride in the ownership of one’s own expert knowledge. Quite often employees fear that if they share their knowledge with others, their own position in the organisation will be endangered (Probst et al. 2000, 192−193; Liebowitz 2009, 4). Almost every organisation has people who are reluctant to share the information they possess (Devlin 1999, 179; Liebowitz 2009, 4−5). When employees are valued and they feel secure in their own position, they are more willing to share knowledge (Bennet and Bennet 2011, 38).

Knowledge sharing is dependent on the organisation culture and work norms. Organisations should have strategies for the most important and relevant knowledge which should be fully shared with the employees. Effective organisations do not overload their personnel with less relevant knowledge. Organisation culture has a lot to do with personnel management and willingness to share. The personnel need to shift their attitude from the duty of collection to the *duty of provision*. Organisations’ management systems have to make this clear to all employees (Probst et al. 2000, 167, 173−175, 192−195, 204−206; Bennet and Bennet 2011, 36−38). Devlin (1999) has a similar view on culture’s role: when something is wrong, the problem typically lies in social and cultural factors. Culture is crucial to the creation of efficient working infrastructure where specific expertise can be acquired (Devlin 1999, 141).

Organisations’ political and power-based barriers are of great significance in knowledge sharing. Quite often employees think that knowledge is their individual property, and sharing it with colleagues will weaken their position in the organisation (Haldin-Herrgard 2000, 362; Probst et al. 2000, 192−196; Visscher et al. 2006, 31). In fact, these power-related barriers are quite similar to the willingness barrier because they share the common element of losing something.

R.K. Price (2001) also raises traditional working practices as a limiting factor in knowledge sharing. He suggests new organisational activities, like interaction between communities of practice, using modern ICT facilities, collaborative work, providing recognition and prestige, and involving all stakeholders in an organisation’s activities (Price R.K. 2001, 1−7).

According to Geldof et al. (2011), water organisations tend to use solutions that seem to have a bias towards technology, rationalisation, reorganisation, increasing scale, etc. One common aspect of these solutions is that only explicit knowledge is found in protocols, procedures, planning and control

routines, expert systems, etc. This neglect of tacit knowledge is evident (Geldof et al. 2011, 6). Knowledge management technology is important in the securement of performance in a water utility. Bennet and Bennet (2011) point out that technology should be user-friendly, cost-effective and flexible. However, financial constraints are the main barrier to implementation of knowledge management projects at water utilities (Bennet and Bennet 2011, 38).

Management and leadership play an important role for other reasons. If management is weak, unprofessional, not committed to their work, or their appropriate information and communication infrastructures and tools are missing, knowledge does not spread effectively. Proper training has to be arranged for the employees, so that they can fully utilise modern knowledge management tools and understand the importance of knowledge sharing. Bennet and Bennet (2011, 36) emphasise that leadership, support from management, leading by example and integrating personnel in knowledge projects are critical factors in motivating personnel to share information and knowledge. Probst et al. (2000, 194) write about trust and how easily it is lost. Long-term, positive experiences are needed to build it, but gained trust is easily lost due to negative events.

Multigenerational workplaces can be challenging in any organisation. Baby boomers (born 1946−1964), Generation Xers (born 1965−1980), Millennials (called also Generation Yers, born 1981−1999), and Generation Zers (born after 2000) work side-by-side at water utilities. If the challenges in multigenerational workplaces could be overcome, water utilities could benefit from the synergy of employees of varying ages working together. The main challenge is to connect the generations in a way that stimulates their unique knowledge, perspectives, and attributes. Every generation should co-operate, tolerate and accept the other generations, and recognise other generations' preferences, communication styles, work schedules, etc. (Wilson 2009, 48−50).

The traits of different generations are discussed by Grigg and Zenzen (2009). They summarised the traits in the following way (Grigg and Zenzen 2009, 84−85):

- *Veterans (born before 1945): plan to stay with organisation over a long period of time; respect organisational hierarchy; like structures; accept authority figures in the workplace; give maximum effort; preference for informality*
- *Baby boomers (born 1945−1964): give maximum effort; accept authority figures in the workplace; results driven, plan to stay with organisations over a long period of time; retain what they learn; respect for organisational hierarchy*
- *Generation X (born 1965−1980): technologically savvy; like informality; learn quickly; seek work/life balance; embrace diversity; respect for organisational hierarchy and plans to stay with the organisation over a long period of time*
- *Nexters (1980−2000): technologically savvy; like informality; embrace diversity; learn quickly; may need supervision*

Hurley et al. (2007) refer to the young professional's roundtable discussion on generational workforce issues, and conclude that, although the differences between generations are significant, and either positively or negatively perceived, there should be understanding on diverse

perspectives, and personalities. They also emphasise the importance of effective communication and support from all levels of the utility (Hurley et al. (2007, 44−46)

Awad and Ghaziri (2004, 95) consider vocational reinforcers the key to knowledge sharing. Vocational reinforcers include compensation, recognition, ability utilisation, creativity, good work environment, autonomy, job security, moral values, advancement, variety, achievement, independence, and social status.

Nowadays many organisations are hit by the knowledge drain. Knowledge may disappear due to retirement, transfer to another organisation, acute or chronic disease, or death of an employee. Brooking (1996, 9) emphasises that when an organisation loses an employee, it also loses part of its *organisational memory*. Organisational memory is decentralised and consists of independent memories that can die and desert the critical mass at any time. Probst et al. (2000, 219−220) give an example of key workers who have become central and are virtually irreplaceable. Their knowledge pool is so huge that when they leave the organisation the knowledge gap is hard to fill.

An important aspect on knowledge retention is raised by Blankenship et al. (2008). Recruitment of new employees outside of water utility or using internal replacements is a challenge because the water sector is not seen as an attractive option, and the size of personnel at water utilities is so small that possible candidates are hard to find (Blankenship et al. 2008, 10).

3.3.3 Stories and knowledge sharing

Stories, storytelling, narratives, gossip, myths, tales, etc. have been used in organisations since their existence. In any organisation there are *stories* that spread throughout the organisation, and even beyond it. Stories have several roles and tasks in organisations: some highlight past events and cultures, some build institutional memory, some are just gossip. Irrespective of the kind of story in question, the field of knowledge management has taken an interest in storytelling for over 15 years (Cohen and Prusak 2001, 112−125; Snowden 2003, 1−2; Davenport and Prusak 2003, 81−83; Liebowitz 2009, 19−20; Cowan 2014, 109−122). In fact, stories and narratives are nowadays a significant matter in organisations and companies because they provide a practical way for sharing knowledge.

According to Snowden (2003, 12) ‘stories that people tell are a wonderful source of material for understanding culture and discovering examples of knowledge and learning’. Workers discussing with each other and sharing stories are voices of *social capital*. Stories are part of the organisation’s communication, and the many types of stories that are told entertain or inform other people. Stories explain events, communicate lessons learned or communicate, illustrate or bring about cultural messages – values, behaviours, understanding, and aims of the organisation. Stories can also disrupt ingrained thinking, provide a repository of learning, replace user requirement specifications, and enable confession of failure without attribution of blame. Stories on failure can serve as better learning lessons than a lecture on best practices. Stories help in defining groups and linking

individuals to the organisation. For example, if the *story of a disaster* is shared directly with others, it can actually be a uniting experience and a builder of social capital (CEN 2004b, 27−29; Cohen and Prusak 2001, 103−132; Snowden 2003, 1−8; Cowan 2014, 109−112; Visscher et al. 2006, 13).

Snowden (2003, 6−9) highlights mythology's role in creating successful organisations. He states that new organisation mission statements and values have to be filtered through current organisational mythology. Accordingly, new or modified values are more easily rooted in the organisation if they are based on existing *myths*.

Several authors note that narratives should be treated both as an art and a science. Unfortunately, they are not able to give solutions to organisational problems. Stories might indeed be dangerous, fraught with peril. A compelling story may contain bare facts as well as skewed information. The messages delivered by stories are interpreted events conforming to present requirements. The moral attitudes of the speakers towards the events are also reflected in the stories (Cohen and Prusak 2001, 104−111; Linde 2001, 163; Snowden 2003, 1−2; Cowan 2014, 109−118).

Cohen and Prusak (2001, 118−125) identify the following characteristics of stories:

- *one or more main characters, key persons*
- *opportunity or problem, which is faced*
- *challenge accepted or problem solved*
- *success or failure of efforts*
- *place, time, and circumstances where the event took place.*

Cowan (2014, 117) builds the narrative elements of storytelling into characters, facts, events, wisdom and situations. By 'wisdom' Cowan means impacts that the event has, e.g. on the company. Basically, the characteristics given by Cohen and Prusak and the elements given by Cowan are similar and highlight the same aspects of stories.

Narratives vary in length, style, and complexity, and circumstantial details make them vivid and believable (Cohen and Prusak 2001, 114−118). Narratives can be oral, written, filmed, drawn, on databases, on CD-ROMS, etc. (CEN 2004b, 27−29; Cohen and Prusak 2001, 128−129; Linde 2001, 162), although in colloquial language, stories usually refer to an oral telling. In regards to internal communication, Cowan (2014, 119–122) only discusses told stories, which circulate in an organisation. Cohen and Prusak (2001, 112−114) regard narratives as permanent assets, which should be distributed within the organisation, and which should be collected in archives and printed histories.

In organisational knowledge sharing, stories provide the means to make tacit knowledge explicit. Stories told in formal occasions or in informal gatherings reveal an organisation's culture and give

new insights (Visscher et al. 2006, 38). Tacit knowledge can be demonstrated and learned from stories, without the need to explain the ethics, behaviour, or key characters of the stories. For example, when newcomers are integrated into an organisation, they must know the stories and when and where to tell them. Later on, they can shape their own stories within the organisation's context (Linde 2001, 160−162). Social power is built and supported by stories which define social groups. 'Listeners learn by seeing people in action in a story more effectively than they could from abstract tenets that are less memorable and more difficult to apply to real life'. Furthermore, people are drawn together because they share knowledge of stories and their events (Cohen and Prusak 2001, 112).

Snowden (2003,2) uses the term '*anecdote enhancement*', by which he means retelling events directly to others. He suggests that stories have to be told in a convincing and attention-grabbing or retaining way to ensure that communication will be effective. CEN (2004b) points out that good storytelling has the power to convey both specifics and underlying values, to develop understanding of complex relationships, and to handle unpleasant truths. Cohen and Prusak (2001, 107−109) emphasise that stories, or social talk, are vital in building and maintaining social capital. In organisations, trust creation and strengthening of unity also presume that stories are told and listened to, and that chatting and sharing of gossip take place. According to Cowan (2014), stories and narratives engage young people and stimulate them to envision themselves in the situations and to imagine the future. Both positive and negative stories are important in creating credibility and sustaining the future (Cowan 2014, 121−122).

Cohen and Prusak (2001, 109−110) found *gossip* to have many characteristics. Some is malicious and harmful, making fun of the misfortune of others, while some is positive focusing on success and good luck. They also discovered that gossip is generally seen 'as petty, unreliable, intrusive (sticking your nose in other people's business) and sneaky (talking behind someone's back)'. Although gossip may be seen as a waste of time, its social and organisational functions are important in that values and behaviours form in gossiping groups.

It is, however, tricky to define stories circulating in organisations. There are so many organisational story types and several ways to categorise them. Story types belonging to multiple categories include stories pertaining to dignity, value, equity, inspiration, and knowledge, stories of membership, and cautionary tales. Genre-based stories include comic and serious stories, fables, and parables (Cohen and Prusak 2001, 118−119).

Cohen and Prusak (2001, 119−125) present the types of stories that they suggest have the most direct and powerful impact on organisational social capital: organisational myths, hero stories, failure stories, war stories, and stories of the future. By 'myths' Cohen and Prusak refer to fundamental stories related to an organisation's culture. Cohen and Prusak (2001) as well as Snowden (2003) claim that myths explain why the organisation exists, how it works, what its values are, and how it relates to stakeholders and the society. Myths are related to founders or key persons of organisations, critical events and turning points. They are timeless, and are told again and again

(Snowden 2003, 6). Hero stories recount heroic gambles, co-operation, devotion to getting the job done, and fellowship. Failure stories are cautionary and tell about disastrous mistakes. War stories describe disasters. Scenario planning is seen as a version of storytelling; the future is described in a persuasive story that unites organisation members around common goals and working together (Cohen and Prusak 2001, 121−125).

3.3.4 Role of networking

Like knowledge management, networking can be defined in many ways. Networks are information and knowledge carriers. They can be categorised, for example, based on their types, span, features, or units. Networks can be functional, organisational, technical, or economic by type and local, regional, national, or international in span. They can feature positions, processes, structures, or relationships, and unite people, departments, companies, or multinationals. In organisations, knowledge exists in networks and communities, and its codification is difficult because of its tacitness (Cohen and Prusak 2001, 53−80). Informal networks' role in organisations is noteworthy in regards to transferring knowledge around the organisation and among its members (Heath 2003, 185, 188). Informality and lack of documentation makes informal networks unavailable to those who might need them (Davenport and Prusak 2000, 38). The emphasis of next paragraphs is on organisations and their internal and external networks, especially awareness and access networks.

Networks cannot exist without social capital and trust, which are needed in creating networks between people and different organisations. People are joined by networks or communities because they share common interests, experiences, goals, or tasks. Field (2003, 1) summarised social capital into the words, *relationships matter*. Cohen and Prusak (2001, 55−57) found the following differences between communities and networks:

(i) communities are more concentrated and focused than networks

(ii) communities have a centre, networks do not

(iii) communities are norm-based, networks are not

(iv) membership in communities is closed, while open in networks.

Dalkir (2011) states that communities provide a good individual, reference and knowledge base to solve problems, make decisions, improve work procedures, and share experiences and expertise (Dalkir 2011, 171−174).

Networks do not benefit only their members but also the whole organisation. On the individual level a network is a powerful tool through which people can get and share information and knowledge, get recognition, have a chance to develop ideas, learn from others and pursue their own goals. All of this can be used to benefit the organisation, too. Organisations should recognise the value of networks and offer opportunities and time to participate in networks or communities of practice or, for example,

transfer personnel between units (Cohen and Prusak 2001, 86−191); Field 2003, 136−145; Lubit 2001, 173−176; Grigg 2006, 96−97); Field (2003, 1) included the concept of social capital in networks and stated that 'the more people you know, and the more you share a common outlook with them, the richer you are in social capital'. Social capital should be understood both vertically and horizontally, since associations between people, and behaviour within and among organisations are the core of social capital. Horizontally, communities get sense of identity and common purpose, but if the ties are not bridging, the network might act negatively and preclude sharing of information and knowledge (Dalkir 2011, 170−171). Some characteristics of social capital are shown in Table 3.12.

Table 3.12 Selected characteristics of social capital, its existence and value of sharing.

Characteristics of social capital	**Source**
Social capital refers to the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions. Social cohesion is critical for societies to prosper economically and for development to be sustainable. Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together.	World Bank 2005
Refers to features of social organisations such as networks, norms, values and social trust that facilitate co-ordination and co-operation for mutual benefit and goal achievement.	Putnam 2000
Social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind the members of human networks and communities and make co-operative action possible. This kind of connection supports collaboration, commitment, ready access to knowledge and talent, and coherent organisational behaviour.	Cohen and Prusak 2001
By making connections with one another, and keeping them going over time, people are able to work together to achieve things that they either could not achieve by themselves, or could only achieve with great difficulty. People connect through series of networks and they tend to share common values with other members of these networks; to the extent that these networks constitute a resource, they can be seen as forming a kind of capital.	Field 2003

Cohen and Prusak (2001, 81−101) explain how social capital may benefit organisations. Some of the ways are related to organisational knowledge management, like maintaining and sharing knowledge, while others foster organisations' internal and external co-operation atmosphere. Shared organisational goals, understanding and stability are also mentioned as benefits. Collaboration plays a key role in social networks, and has several aspects, as shown in Figure 3.9.

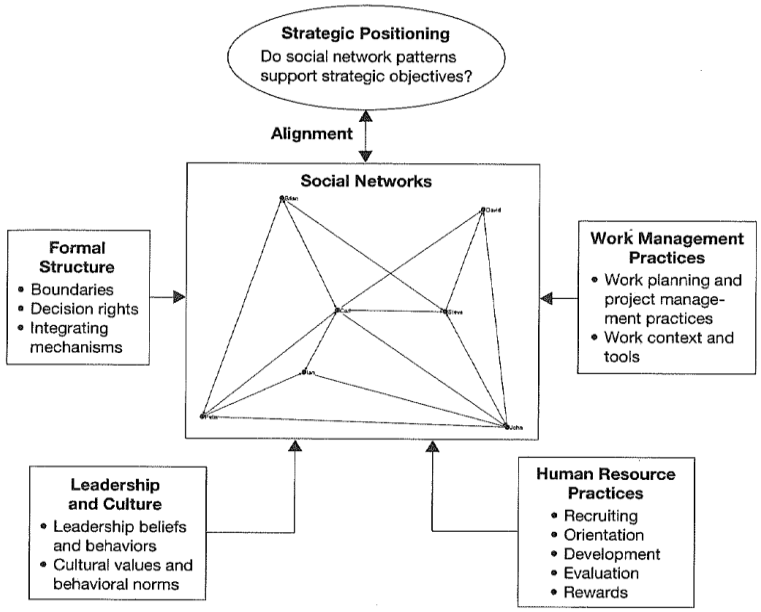

Figure 3.9 Key aspects of collaboration in social networks (adapted from Cross and Parker 2004,117, reproduced with permission from Harvard Business Publishing).

The idea with Cross and Parker's model is not to apply all of the aspects in organisations, but to concentrate just on the most relevant ones that promote connectivity. Some organisations should concentrate on formal structures while others might concentrate on work management, human resources practices or just some sub-aspects (Cross and Parker 2004, 115−130).

Cross and Parker (2004) divide networks into *awareness networks* and *access networks*. The awareness network is related to 'who knows what', and is usually connected to groups and their members' expertise. In their studies, Cross and Parker found that group members were 'unfamiliar with their colleagues' abilities and were not exploiting the best experience of their team'. The access network indicates 'who can reach whom'. In a network it is necessary to know who is accessible to whom, because the group's activity depends on those contacts. The access network forms a continuum with powerful or busy people at one end with whom one cannot get in touch, while there are people at the other end who are valuable information sources with expertise in the matter in question. However, neither of the networks alone is an effective network for social context. The best result, for example, in responding to new opportunities and discovering people who are peripheral in the organisation, is achieved by combining awareness and access networks. Cross and Parker noticed in their studies that administrative personnel tend to be inaccessible, and have become estranged from the daily routines of their subordinates (Cross and Parker 2004, 31−43).

Similarly, Leonard et al. (2015) refer to the *deeply smart persons*, who have created their networks during the years and know, depending on the case or information needed, whom to contact. They

emphasise that these kinds of networks and their links to other networks are not directly transferrable to, for example, successors.

Allee (2003, 114−116) uses the term *informal knowledge sharing networks*. In such networks, particular topic related knowledge – and stories and gossip – are shared between two people, not the whole group. An informal knowledge sharing network seems to have characteristics of both awareness and access networks. On the other hand, Allee's informal knowledge sharing network is similar to Cross and Parker's (2004, 44) *information flow network* which, according to them, reveals to whom to turn for information to get your work done. Another type of network Cross and Parker (2004, 44−47) mention is the *problem-solving or brainstorming network*, which is used when there is a need for expert help or capacity for innovation. The question with this type of network is to whom do you typically turn for help when thinking through a new or challenging problem at work?

Allee (2003) makes a distinction between *communities of intere*st and communities of *practice.* Communities of interest networks are informal and loose networks that keep their members informed. Networks share a common interest, but do not engage in community learning or expertise improving. The idea behind communities of practice is that people learn from each other, thereby increasing their knowledge and skills. All kinds of knowledge sharing tools are used to accomplish the network's mission (Allee 2003, 113−130).

It is typical in informal networks that relationships are always shifting and changing. It does not matter what kind of *rules* or *procedures* are applied in decision making in the organisation, if things are to be made to happen. Formal positions and responsibilities are bypassed, and contacts will be established with trustworthy people (Allee 2003, 114−116; Field 2003, 2−5).

Awareness of who has what kind of expertise in an organisation can be raised and collaboration improved by, for example, communities of practice or face-to-face interactions, such as knowledge fairs. In the water sector, the World Bank's strategy favours knowledge fairs. Accessibility, in turn, can be increased technically, for example, by e-mails and video conferencing or by creating possibilities for face-to-face access, or by using co-workers or colleagues to guide major tasks. Although peripheral workers miss the common coffee table discussions and information sharing of the organisation, they may be able to join the collaboration if they know about the awareness and access networks (Cross and Parker 2004, 35−40).

Organisations have both internal and external knowledge networks. As concerns the internal networks, Cross and Parker (2004, 44−47) found out that even though secretaries and office managers play co-ordinating roles in a *communication network*, their role in, for example, solving complex problems or devising new products is not a strategic one. Organisations and their members are linked to several stakeholders outside the organisational boundaries, like customers, suppliers, business partners, contract workers, or consultants. Allee (2003, 115−116) describes *intelligent synaptic webs*, where internal expertise search for knowledge and ideas from larger social systems.

3.3.5 Role of employee orientation

A successful workplace orientation develops the newcomer into the employee and integrates them into the work culture. In the workplace orientation process the challenge is how to motivate the younger employees and the experienced employees to discuss together. In a way workplace orientation can be seen to be a part of information and knowledge sharing.

Workplace orientation has been discussed by Tyson (2006), who uses the word '*induction*', which refers to the formal process of placing someone into a new job. He stresses the importance of an induction programme in the introduction of new employees into the organisation. The aim of an effective induction programme is to integrate the newcomer into the organization and its environment socially and functionally. Tyson points out that comprehensive information on the conditions of employment, working arrangements, staff development and welfare and recreation services offered to employees should be provided in a reasonably long period of time. The induction programme should also be monitored and its total effectiveness assessed (Tyson 2006, 185–191).

Organisations have to take into account several issues when hiring new employees or shifting personnel to new positions. In Finland the Occupational Safety and Health Act (738/2002) obliges the employer to orient the employee to their work, working conditions and to the correct use of tools and safe work procedures.

Usually organisations have formal workplace orientation schemes or programmes for newcomers. The purpose of the workplace orientation is to give a clear understanding of the organisation, its organisational structure and vision, procedures and regulations, practices and the tasks of the newcomer. It is especially important that orientation is carried out smoothly and within a sufficient timeframe. A final evaluation of the workplace evaluation process usually ends the formal orientation. Workplace orientation is often provided by the employee's supervisor. In large organisations the human resources department also participates in the orientation process. Introduction to co-workers and a tour of the work area form parts of the orientation.

3.4 Knowledge retention

The existing literature on knowledge retention in organisations is extensive and focuses mainly on knowledge management systems, preserving knowledge and how the once collected knowledge may be lost. However, only a limited number of publications on knowledge retention at water utilities exist. Challenges in knowledge retention are closely related to the difficulties in sharing information and knowledge explained in Sub-chapter 3.3.2. Here, the approach is on knowledge retention and organisational forgetting.

3.4.1 Employees and organisation memory

The personnel of an organisation is its core asset. Human capital or human-centred assets fall into the broader concept of intellectual capital, of which the other components are market, intellectual property, and infrastructure assets. Intellectual assets are intangible, e.g. know-how personnel possess, trade secrets, processes, technical information, etc. Organisations generally invest years of work in creating intellectual capital assets, which in fact create value for the organisation (Brooking 1996, 13−15; Dalkir 2011, 333).

Each organisation should understand how valuable its personnel are. An organisation's success depends on the employees' *skills and knowledge*, attitudes, and technical competence. In this sense, the personnel are a unique asset, of which the organisation has to take care of, and in whom the organisation has to invest (Brooking 1996, 15; Post and Breen 2005, 44; Leonard and Swap 2004, 88−90).

In referring to human-centred assets, Brooking (1996, 15, 43−61) means a combination of *expertise, creativity, problem solving skills, leadership and managerial skills* which the personnel have embodied. Organisations have also gained psychometric data and indicators on their employees by which they can evaluate the personnel's *ability to co-operate* or work under hectic situations. Managers should pay attention to the employees' abilities and potential and give them a chance to work performing a variety of tasks instead of only one particular task. Brooking (1996, 15) emphasises that the tacit knowledge of the personnel belongs to them, not to the organisation. The role of the organisation is to understand employees' knowledge and skills and how they can benefit the most from their personnel. To balance this derived advantage, the organisation pays salaries and gives the personnel possibilities to develop themselves, both on a personal and professional level. Probst et al. (2000, 18−21) agree that the success of the organisation depends on an efficient combination of employees' knowledge and other knowledge components.

The knowledge stored in team or organisational routines remains accessible as long as people and teams are available. Thereby their knowledge is memorised by the organisation. The other option is to institutionalise knowledge as so-called structural capital within the organisation's structures, processes and culture (CEN 2004a, 10).

Water utilities of the 21st century have to cope with diversity of knowledge, skills and expectations of their personnel. Technological developments in communication systems, frequent information exchange, performance goals, need for supportive management and leadership combined with the younger generations' expectations and career goals pose challenges to water utilities. Building, maintaining, developing and sustaining human capital will be a success factor for water utilities in the years to come (Post and Breen 2000, 47).

The role of younger generations is also discussed by Hurley et al. (2007). Young professionals have pointed out several perspectives and actions which could be beneficial in cases where several

generations work in utilities at the same time. It is evident that generations differ from each other, due to the fact that their professional backgrounds, experiences in the field, and skills, e.g. ICT skills, can vary greatly. Generational differences should be identified and the gathered knowledge should be used to improve communication at all levels of the utility. When asked, young professionals thought that critical knowledge could be easily identified and passed down by working together. This could also promote innovation creation. Commitment and time were key prerequisites for knowledge transfer. Coaching and mentoring were seen as effective means to improve communication. New employees benefit from supportive and open learning cultures, so they can develop professionally (Hurley et al. 2007, 44−46).

In 2002, the Board of the Finnish Water Utilities Association (FIWA, Vesi- ja viemärilaitosyhdistys formerly Vesilaitosyhdistys, currently Vesilaitosyhdistys) presented the Finnish water utilities 2020 goals and roadmap. One of the actions deals with the human resources policy issues at water utilities. Not only water utilities, but the whole water industry should develop their attractiveness. The recommendation at that time was that actions should be taken at the beginning of the 21st century, immediately, when the baby boomers start to retire. Water utility should be able to offer interesting positions and options for career development. Another recommendation deals with research at water utilities. A suggested goal was that by 2020, water utilities should have an established network with researchers and financiers to increase research activities and gain new knowledge (Vesi- ja viemärilaitosyhdistys 2002, 1).

3.4.2 Learning, training and skills

Organisational knowledge and organisational learning depend partly on human-centred assets. According to Probst et al. (2000, 21), organisational knowledge may be concentrated in individuals, but an organisation's problem-solving ability cannot solely be explained by employees' individual skills. Organisations will survive only if collective knowledge, which is more than the sum of the knowledge its members hold, is fully utilised. In organisations, new knowledge is developed by solving current problems occurring while performing tasks and combining the solutions with the organisational processes and personnel's skills. In fact, it is a question of spreading the best practices within an organisation (Probst et al. 2000, 130−162).

Every organisation has competence typical for its own field. Employees develop skills on-the-job. Many employees gain skills over decades; the process is partly tacit. People learn about 80 percent of their skills at work. Only 20 percent is learned through formal education or training organised outside the workplace. If the tacit knowledge created in daily work could be made visible and fully utilised, organisations would learn and develop faster (Toivonen and Asikainen 2004, 11−13). Koskinen and Vanharanta (2002) describe action learning in the engineering field. Action learning is a social process in which employees learn with and from each other by solving actual problems and doing practical work. Koskinen and Vanharanta emphasise that action learning involves elements of

both explicit knowledge and tacit knowledge: the learning is partly from printed materials and partly through experience, questioning and reflection (Koskinen and Vanharanta 2002, 57−59).

Integrated workforces and knowledge management in evolving environments of water utilities is discussed by Grigg (2006). He summarises several studies and notes that formal training can provide only some knowledge of engineering, science, operation and maintenance. Experience at water utilities and on-the-job training has to provide the needed expertise, because water utilities need stable technical workforces which cannot be directly transferred from other industries (Grigg 2006, 92−93).

Education needs at Finnish water utilities are addressed in a study on the development of Finnish water services completed in 2007. The recommendation is that education and training has to be developed by all actors in both the education field and at water utilities (Silfverberg 2007, 31 – 32). A study completed in 2015, considers education needs of a highly educated workforce at water utilities. Recommendations are set out for three scenarios, which tackle different approaches. The scenario on improvement of attractiveness of water utilities concentrates on the necessity of the content of formal education in universities and universities of applied sciences meeting the needs of water utility employees and safeguarding a sufficient number of those employees (Salminen et al. 2015, 33−36).

In Finland formal water sector education can be received at universities, polytechnics (universities of applied sciences) and vocational education institutes. Typically, managerial and planning-level tasks require a university or polytechnic-level education, while shop floor tasks require a vocational education. Besides having a formal education, water utility personnel have to prove their skills, such as in technical utility operations and water hygiene, a requirement of the Decree of the Ministry of Social Affairs and Health on Skills in Technical Utility Operations and Water Hygiene Required of Persons Employed at an Establishment Supplying Water Intended for Human Consumption and on Skills Testing (1351/2006), and some workers must have a hot work licence, a certificate of hot work training given by the Finnish National Rescue Association. However, a large percentage of the employees of water utilities lack formal training in water engineering. Therefore, on-the-job training and vocational education is a significant part of the industry, as is touched on below.

Vocational qualifications are based on what an individual does in the workplace. They are intended to allow the individual to prove that they have the skills, knowledge and understanding for doing a job well. Formal, professional education gives general qualifications for the job, but particular knowledge and skills are learned on-the-job.

Vocational education is arranged both at educational institutions and in the form of apprenticeship training. Vocational education combines theoretical studies and on-the-job training at actual workplaces. In apprenticeship training, the student, that is, the employee has a fixed-term contract with the organisation. The training involves normal work. Another possibility is to take a so-called *competence-based test* where employees can demonstrate through a practical test that they have

the skills and knowledge needed for a given occupation, regardless of how they acquired that knowledge. Adults already active in the labour market can demonstrate their knowledge and skills through competence-based tests, without preparatory teaching, and thereby gain initial vocational, further vocational or specialist qualifications (Ministry of Education and Culture 2016; Ministry of Education 2005).

In 2004 there were no initial vocational qualifications in the Finnish water sector. At that time, plans for arranging vocational education in the form of competence-based tests for the water sector were in progress, and the Further Qualification in Water Supply and Sewerage (Vesihuoltoalan ammattitutkinto) was ratified in 2006 and the Specialist Qualification in Natural and Environmental Protection, Specialisation in Water Supply and Sewerage (Ympäristöalan erikoisammattitutkinto, Vesihuollon osaamisala) in 2013 and reformed in 2015. Further vocational and specialist qualifications is essential for water utility personnel, as it gives them the required knowledge and skills and an official certificate of their competence (Lounemaa 2005; Opetushallitus 2006; Opetushallitus 2015). Supplementary education and training courses for water utility personnel will be organised by FIWA.

In organisations, learning also takes place in meetings and other discussions. The prerequisites for learning in these settings are social skills and a good working atmosphere. If the working environment understands and accepts differences, learning together can foster the learning process and enable learning from each other. Everyone can learn: newcomers from those with much working experience and vice versa (Toivonen and Asikainen 2004, 33−35).

Leonard and Swap (2004, 92−97) introduce the *deep smarts* concept. The phases towards deep smarts, from passive reception to active learning, are: directives, presentations, lectures, rules of thumb, stories with a moral, socratic questioning, guided practice, guided observation, guided problem solving and guided experimentation.

Leonard and Swap's concept relies mainly on experience-based gathered tacit knowledge, especially know-how, but often know-who. Even though their studies deal with novice entrepreneurs and experienced managers, the findings are applicable in almost any organisation. In fact, Leonard and Swap's concept is similar to the master–apprentice model.

In addition to guided experience, Leonard and Swap (2004) refer to learning-by-doing, combined with feedback from a knowledge coach, a person who is willing to share knowledge. Knowledge coaches can have several roles, such as that of a mentor, an advisor, or a teacher. Learning-by-doing creates deep understanding and requires active engagement from both the teacher and the student. The lasting assets are the transferred know-how and delivery of new business processes, product ideas, or capabilities. 'Guided experience increases value exponentially – it promotes dual-purpose learning and builds on all that we know about how people accumulate and retain knowledge' (Leonard and Swap 2004, 94−97).

Boiral (2002) describes knowledge management in the context of environmental issues. He concludes that custom-made training programmes should be implemented if environmental knowledge and behaviours are to be learned. During the training, organisation members should be able to share their experiences and tacit knowledge as well as adapt explicit knowledge on environmental issues. Organisation members learn new behaviour only if they understand the important message of the training, and are willing to externalise practical knowledge into explicit knowledge (Boiral 2002, 309−312).

3.4.3 Knowledge and organisational forgetting

Organisational forgetting represents, in a way, underutilisation of knowledge. If the knowledge gaps in organisations are not discovered, the added value of knowledge will be lost. The organisational knowledge process is a continuous task, which includes further identification and creation of knowledge (CEN 2004a, 5, 11).

Preserving knowledge and organisational forgetting are discussed by Probst et al. (2000). Their approach to preserving knowledge is for organisations to avoid knowledge gaps and highlight the role of collective memory. Knowledge preservation processes consist of selecting the material worth retaining, storing it in a suitable form in the organisation's knowledge base and updating the knowledge (Probst at.al. 2000, 217−241).

DeLong (2004) uses the terminology *lost knowledge*, by which he means decreased capacity for action or decision making in specific organisational contexts. Knowledge can be lost at the organisational or functional level, in work units or at the small group level or at the individual level. When this happens, the organisational memory is degraded (DeLong 2004, 19−25). This approach is similar to that of Probst et al. (2000), who identify the reasons for *organisational forgetting*. The forgetting modes are divided into *erased memory contents* and *memory access lost* either temporarily or permanently. Both forgetting modes can occur in individual, collective or electronic memory. At the individual level, the memory content may be erased by resignation, death, forgetting or early retirement. Collective memory may be erased by dispersal of established teams, re-engineering or outsourcing of functional areas. Electronic memory content may be lost, for example, by system and hardware faults or viruses. Memory is sometimes only blocked temporarily. Work overload, transfers, illnesses, holidays, lack of training, and working rules may temporarily block access to memory at the individual level. On the collective level access may be temporarily blocked by taboos on old routines and collective sabotage. Temporary electronic memory access problems may occur if data is lost due to overload or interface problems. Permanent memory access blocks may occur if workers are overloaded with work, they are not aware of the importance of their knowledge, or they are unwilling to share their knowledge. Collective memory is permanently blocked in cases where the company or its parts are sold, or teams are transferred somewhere else. If the electronic memory is permanently inaccessible, the reason may be system incompatibility,

overloading or incorrect indexing (Probst et al. 2000, 238−239). Table 3.13 summarises organisational forgetting, which can happen in different forms.

Table 3.13 Organisational forgetting (adapted from Probst et al. 2000, 239, Managing knowledge : building blocks for success by PROBST, GILBERT ; RAUB, STEFFEN ; ROMHARDT, KAI. Reproduced with permission of JOHN WILEY & SONS, INCORPORATED in the format Other Published Product via Copyright Clearance Center).

Mode	Individual form	Collective form	Electronic form
Memory content erased	Resignation Death Forgetting Early retirement	Dispersal of established teams Re-engineering Outsourcing of functional areas	Irreversible data losses through viruses, hardware faults, system crashes, missing back-ups, hackers
Access not possible / temporary	Overload/temporary transfers Illness/holiday Lack of training Working to rule	Taboos on old routines Collective sabotage	Reversible data losses through overload / temporary interface problems
Access not possible / permanent	Overload/permanent lack of awareness of own knowledge Inner withdrawal	Sales of parts of company Transfer of teams Cover-up	Permanent incompatibility of systems Overload / permanent Incorrect indexing

Blankenship et al. (2008) as well as Blankenship and Brueck (2008) divide difficulties in retaining knowledge into technology-based, interaction-based, and learning culture-based categories. Difficulty of knowledge retention varies between these three approaches. Technology-based methods deliver information and facts, which are easy to capture and write down. This type of method is at the lowest level of the knowledge value chain. These authors also relate this approach to document systems, and document repository forms of knowledge retention. Processes and practices are part of the interaction-based category, which includes the core competencies at a water utility and which can be difficult to capture. A milestone review project is an example of processes and practices. However, the most difficult approach is the learning in the culture-based approach, which comprises knowledge in complex systems and best practices. Tacit knowledge incorporated in the learning-culture-based approach has the highest value in the value chain of knowledge. It gives answers to “know-how” and “know-who” (Blankenship et al. 2008, 7; Blankenship and Brueck 2008, 58−59).

Employee retention is discussed by Grigg and Zenzen (2009, 133−140) from the point of view of retirement or leaving for other reasons, like reorganisations. They noted the importance of retention, i.e. keeping tacit knowledge in the corporate memory and saving in indirect costs, such as training and development of personnel.

The project conducted by Blankenship from 2005 to 2008 showed that the biggest barriers in knowledge retention at a water utility were lack of time, competing priorities, and lack of expertise in retaining knowledge. Social network analysis, document repository, retirees' incorporation, mentoring, and organisational learning and training were the approaches tested at water utilities to find out the best way to use them. For document repository, utilities should develop a standard procedure to store and update critical information, and create manuals and record-keeping formats to facilitate effective, time-saving knowledge transfer. At some water utilities in the USA, retirees have been rehired to specific tasks either to train new personnel, to document critical knowledge, or to assist in knowledge transfer. Another option used by top management is to transfer retiring personnel to work together with a newcomer for one year before retirement. Volunteer information and knowledge documentation and distribution has also been applied in the USA (Blankenship and Brueck 2008, 59−61).

Kaspersma's study (2013) on the water sector and the Rijkswaterstaat in the Netherlands shows that knowledge is lost because of the lack of succession planning and the high mobility of the workforce. She also tackles the question of ageing personnel and reorganisation in the Rijkswaterstaat, which have led to a brain drain. The organisation structure aims at lower bureaucracy, and the retired personnel are not being replaced by younger ones. This, in fact, was found to be against the Rijkswaterstaat's focus on expanding the collective memory. The study's outcome shows that the tacit knowledge is not being transferred and it will disappear from the organisation. Other reasons for loss of knowledge are outsourcing, lack of communication between stakeholders, and a strong focus on process management while paying little attention to substantive knowledge (Kaspersma 2013, 130−134).

Barriers to knowledge retention are also discussed by Liebowitz (2009). According to him, one of the key obstacles in institutional knowledge retention is personnel. Some are reluctant to share their knowledge, because they consider their knowledge as a competitive edge. Personnel want to be recognised or want some reward for sharing their knowledge. Of the human biases, recency, causality and imaginability could impact the conveyed and captured knowledge. For some reason, personnel might not participate in knowledge retention efforts or might sabotage them. Liebowitz also notes that when long-time personnel retire, it is not possible to capture the knowledge gained over the years in an interview lasting a couple of hours. The last point about the obstacles he mentions is the misalignment of knowledge retention strategy with the strategic mission of the organisation and poorly designed knowledge management programmes (Liebowitz 2009, 4−6).

Tacit knowledge can be transferred by mentoring. Especially technical and operational knowledge, organisational culture, and leadership knowledge can be transferred effectively during a mentoring process. Best practices can be transferred in facilitated organisational learning and training sessions. Special apprenticeship training programmes have been used in integrating new personnel at water utilities (Blankenship and Brueck 2008, 61).

An easy way to keep critical knowledge within the utility is to make generations work together. Other knowledge sharing tools include training, mentoring, coaching, career development, and shadowing, where a younger employee follows how a senior employee works. Mentoring and coaching are effective tools in transferring knowledge and organisation culture, if mentors and coaches can communicate clearly on utility issues, and can allocate time for new employees. Hurley et al. (2007, 45−46) emphasises open organisational culture, effective communication, and support from all employee levels regarding knowledge transfer. Post and Breen (2005, 47) stress that not only skills and knowledge, but also enthusiasm and loyalty transfer during mentoring.

Knowledge losses may also occur in cases other than retirement. Blankenship and Brueck (2008) and Baker et al. (2004) anticipate that younger generations will have shorter tenures, because they seek other job opportunities. Their knowledge should therefore also be captured. Thus, commitment and support by the top management is a basic requirement for knowledge retention. Water utilities need to develop workforce planning schemes, hiring practices, personnel compensation, rewarding, recognition, and promotion actions that support knowledge retention. Development of workforce strategy should be one of the priorities of the utility (Blankenship and Brueck 2008, 61; Baker et al. 2004, 2).

Frigo (2006) describes the need for integrated knowledge retention strategies at water utilities. According to him, the key focus of the top management should be on the strategies that link together human resources processes and practices, information technology solutions and knowledge transfer practices and recovery initiatives. A knowledge retaining strategy and its implementation should be an ongoing activity at the utility (Frigo 2006, 83−84). Knowledge retention strategies and retiring employees are also discussed by Blankenship et al. (2008, 2), and in that context they emphasise that utilities have to make a distinction between explicit, implicit, tacit and evident knowledge.

Blankenship et al. (2008) link awareness and knowledge retention and emphasise their role in knowledge retention strategies. Explicit knowledge is easy to maintain and retain, since employee and other employees know something which they can write down or codify. In case of implicit knowledge employee knows something, but does not share or document it. Thus, implicit knowledge is not readily retained nor readily transferred to other employees. If employee does not know something and other employees see it and give knowledge to employee, knowledge is retained and transferred. Tacit knowledge is not written or articulated, and is thus most difficult to retain (Blankenship et al. (2008, 2−3).

Liebowitz (2009) uses four pillars of knowledge retention: recognition and reward structure, bidirectional knowledge flow, personalisation and codification, and the golden gem. There are numerous means to recognise and reward employees for knowledge retention activities and therefore communicate the importance of knowledge. Knowledge should flow from the bottom up: senior employees could pass knowledge to junior employees and juniors to seniors. Personalisation refers to the means to capture and transfer knowledge between employees, and codification refers

to the systems and repositories that share knowledge. With the last pillar, the golden gem, retired employees remain involved with the organisation (Liebowitz 2009, 26−29).

3.4.4 Knowledge retention tools

Numerous studies deal with knowledge retention tools. Some of the tools are rather formal and are based on organisations' knowledge strategies, while others rely on the activity of collecting data, information or knowledge. Collectively, these studies outline the importance of collecting, sharing and retaining knowledge in organisations.

DeLong (2004, 25) states that knowledge retention is 'a grounded, practical way of attacking the real threat of lost knowledge'. Knowledge acquisition, storage and retrieval are the key activities of knowledge retention, as shown in Figure 3.10.

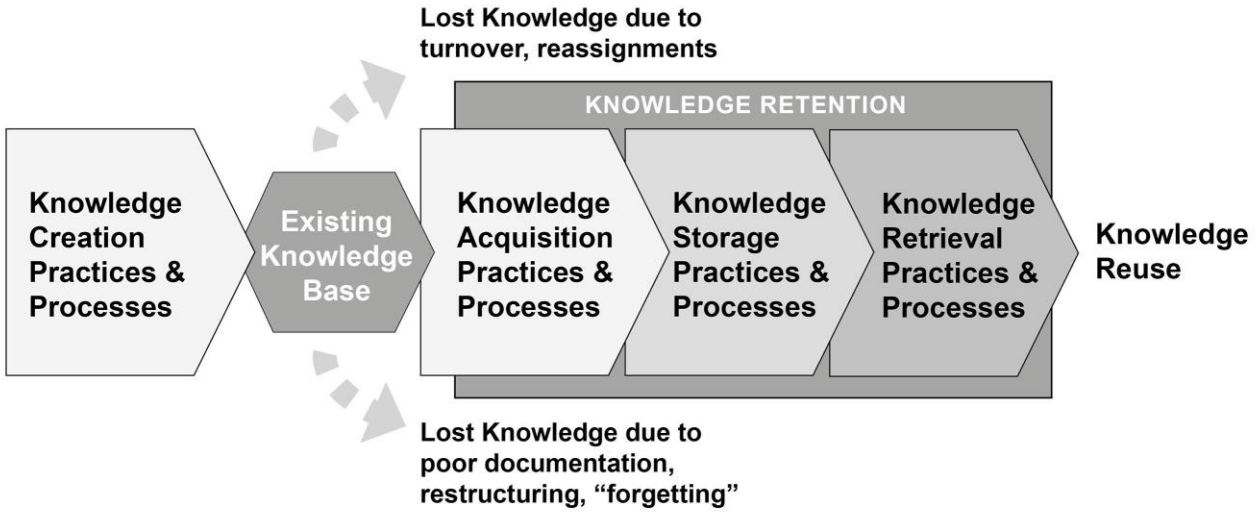

Figure 3.10 Knowledge retention activities (adapted from DeLong 2004, 24, reproduced with the permission from Oxford University Press).

Based on findings from knowledge management companies, Grigg (2006, 96) presents the following categories for tools and methods:

- *analysis and synthesis tools, like social network analysis and knowledge mapping*
- *communication and relationship, e.g. peer mentoring, communities of practice, conferences*
- *information systems, e.g. document management, records management*
- *learning systems, like distance-learning*

- *management systems, e.g. best practices, project management, digital asset management*
- *software, among others data analysis and groupware*
- *Web knowledge portals and systems, e.g. the internet, intranet.*

Building on the Weggeman's knowledge management process model in the water and sanitation sector (discussed in Sub-chapter 3.2.5), Visscher et al. (2006) point out numerous tools that could be used in each process phase. Benchmarks, roadmaps, brainstorming sessions and interviews can be used when a water utility identifies knowledge needs. In the knowledge development phase, creation and evaluation of innovations, brainstorming sessions and training can be utilised. Collecting and storing information is done through formal documentation, i.e. databases, webpages, libraries and archives, and capturing knowledge in exit interviews. Sharing knowledge and information is made possible through printed or electronic publications or other digital formats, intranet, job rotation, apprenticeship, mentoring, coaching, storytelling occasions, etc. In the applying and maintaining knowledge phase, useful tools include following and adapting new technological developments and best practices. The last phase is evaluation of the content and knowledge management process and adaption of further developments when needed (Visscher et al. 2006, 26-27).

APQC (2013) gives examples from fields outside of water sector, but the approaches are quite similar to the Visscher et al. (2006) approach in the water and sanitation sector. The key approaches include communities of practice, transfer of job-related knowledge, mentoring and apprenticeship programmes, use of subject matter experts, storytelling programmes, partnership with in-house training organisations, integration with the employment life cycle, and leveraging retirees. Knowledge audits, handoff documents, lessons learned, and structured interviews can be used in job-related knowledge. Mentoring and apprenticeship programmes can be valuable tools in transferring knowledge, especially tacit knowledge, in leadership, behavioural and skill development (APQC 2013,1−7).

In his book, Liebowitz (2009) discusses knowledge retention tools from the organisational strategies creation point of view. Interviews focusing on decision making, mentoring programmes, oral histories (storytelling), after-action reviews, exit interviews, cheat sheets, the bibles, online communication, wikis, blogs and social networking sites were explained to be effective tools for retaining knowledge for the benefit of the whole organisation. Exit interviews can be successful if the knowledge capturing process starts two to three years before retirement. Liebowitz stresses that employees' personal notes, cheat sheets, contain valuable information on accomplishment of tasks and processes, which should be made available for other employees. Processes related to organisation's key competencies and how to do them or what should be avoided, could be collected in special books, 'the bibles' (Liebowitz 2009, 15−24).

A list of “Top 10 Retention tools” may be used in implementing knowledge strategy at water utilities. The tools, originating from APQC’s model on needed human interactions in knowledge capture, are categorised into four groups as follows (Blankenship et al. 2008, 13, 27):

- *self-service+ (note: + means that human interaction is needed to support transfer of knowledge): knowledge yellow pages, knowledge repository; tools and systems that allow users to self-serve knowledge or find experts*
- *process-based: storytelling, lessons learned, after action reviews; systematic tools to gather process-specific knowledge and reapply to relevant situation*
- *network: community of practices, incorporating retirees, virtual collaboration, mentoring; groups that share and learn, held together by common interest in the topic, solve business problems, trade tools, templates, best practices*
- *facilitated best practice: organisational learning and training; facilitated sharing transfer and internal benchmarking.*

Several tools that could be used when utilities assess the effects of workforce changes are pointed out by Frigo (2006). These tools include retirement profiles, which describe when the personnel will retire, tenure profiles, which describe the personnel’s working experience at the utility, and critical knowledge at risk profiles, which identify the severe effect on operations when an employee leaves the utility. The knowledge, which is critical for operating the utility, can be traced through employee interviews (Frigo 2006, 82−83).

The social network analysis could be an appropriate tool to be used prior to deciding which knowledge retaining approaches could be applied at a utility. It shows patterns of interactions and knowledge sharing, and it is used in the development process of a knowledge retention strategy for a utility. The strength of social network analysis is that, besides the linkages between employees, the potential weaknesses of knowledge sharing between different units or teams can be located (O’Berry 2007, 45−46).

Both Probst et al. (2000) and Blankenship and Brueck (2008) highlight several ways to maintain contact with retired or leaving employees. Retired managers can be used as experts for management-supportive actions and in projects. A systematic transfer of skills from retaining employees could be achieved by training successors over a long period. In the master-apprentice system, older and younger employees work side-by-side, and from the close relationship, the younger employee can gain knowledge and skills from the older employee. Valuable information can be collected in leaving interviews, where documents, projects and contacts are made explicit (Probst et al. 2000, 227−230; Blankenship and Brueck 2008, 60−61).

The important role of retired employees is also discussed by Liebowitz (2009). Examples of the formal programmes where organisations have utilised the knowledge and skills of retired employees are: phased retirement (part-time working at the retirement-age), retiree job bank (part-time work after the retirement), emeritus programme (work periodically), consultant (part-time project team

work), mentoring programme, knowledge sharing forums, rehearsal retirement (on pension and after a certain period back to work), job sharing, facilitator or moderator (online community) and knowledge retention programme (like videos of interviews) (Liebowitz 2009, 28−29, 75−77). Knowledge retention processes and tools are summarised in Table 3.14.

Table 3.14 Processes and tools used to trace explicit and tacit knowledge of competent performers and experts (Liebowitz 2009, 77, reproduced with permission of Auerbach Publications in the format Thesis/Dissertation via Copyright Clearance Center).

Nature of expertise	**Competent performers**		**Experts**	
	Weeks	Months, years	Weeks	Months, years
Explicit	Documentation, interviews	Best-practices, training courses, embed in processes and tools	Not applicable. Expertise is developed over years of hands-on practice.	
Tacit	Outsource, retiree programme, knowledge harvesting	Peer reviews, communities, mentoring/coaching, knowledge harvesting, expert systems, job shadowing, rotational assignments	Outsource, retiree programme, knowledge harvesting	Mentoring/coaching

Capturing tacit knowledge can be implemented through succession planning, cross training programmes and employee retention programmes (Baker et al. 2004, 3). For the capture of explicit knowledge, e.g. ‘knowledge comprised of actionable information’, Baker et al. describes one solution of a knowledge management database for electronic documents, which were hyperlinked within the database and to the environmental regulation webpages (Baker et al. 2004, 3−5). The soft areas of knowledge management CEN (2004a, 4) uses are common approaches, identification of good practices, and standardisation initiatives.

Succession planning is a process that enables an organisation to identify internal personnel who can fill important positions in the future. Grigg and Zenzen (2009) discuss the succession management for leadership at water and wastewater utilities. Succession planning is a crucial issue, which should be integrated into the workforce planning process. They emphasise that successors should be primarily identified inside the utility. The process starts by identifying leaders and critical positions. The next steps are identification of talents for future leadership and developing their skills and knowledge through training and development programmes. Finally, when there is a need for a new leader, the selection is made from the pool (Grigg and Zenzen 2009, 141−143).

3.5 Summary

A summary of the selected literature relating to knowledge concepts, different types of knowledge and the importance of knowledge management in organisations has been dealt with in this chapter. Finnish water utilities, like many organisations worldwide, face demographic shifts. Baby boomers are retiring and new generations with new skills are being recruited to utilities. If the capture of existing knowledge is neglected, utilities will lose valuable knowledge. Overall, there is a clear need for retaining knowledge in organisations while there are numerous tools to be applied to manage knowledge. Some of the tools are simple and easily applied to water utilities, while some knowledge management tools need more sophisticated and complex systems to be developed for the needs of the target organisations. Knowledge management is not an independent, one-time effort, thus is should be tightly integrated in each organisation's business strategies and human resources planning strategies.

Knowledge management has for a long time been a topic of great interest in a wide range of fields. The issue of ageing personnel at Finnish water utilities has been gaining attention for years, but there is a lack of studies, especially dealing with tacit and critical knowledge, on water utilities. The key question for Finnish water utilities is what kind of knowledge should be captured, stored and transferred. Chapter 4 presents the results of the case of knowledge at Pori Water, the interpretation of information by the personnel, knowledge management, tacit knowledge, and what kind of information and knowledge acquisition channels were in use. The purpose is to compare and analyse the results gained in 2004 and in 2013.

4 RESULTS OF THE PORI WATER CASE STUDY

4.1 Pori Water in brief

Pori Water is a municipally owned company of the City of Pori, which provides water and wastewater services to its customers. Administratively, it is under the Board of Pori Water, which in turn is supervised by the deputy mayor (formerly technical director) of the City of Pori. In 2004 the Board of Pori Water was called *Porin Veden hallitus*, and since 2009, *Johtokunta.* In 2013 the Board of Pori Water comprised eleven appointed members and their deputies, while in 2004 it comprised nine members and their deputies. Pori City Council appoints the members for a term of four years in connection with municipal elections. The term of new board members started at the beginning of 2013. The board is responsible for the activities, finances and organisation of Pori Water as well as co-operation between municipalities (Porin Veden johtosääntö 2001; Porin Veden johtosääntö 2008; Porin Veden johtosääntö 2014). The two member-increase in the board was due to the extended operational area of Pori Water. The organisation structure of Pori Water is shown in Figure 4.1.

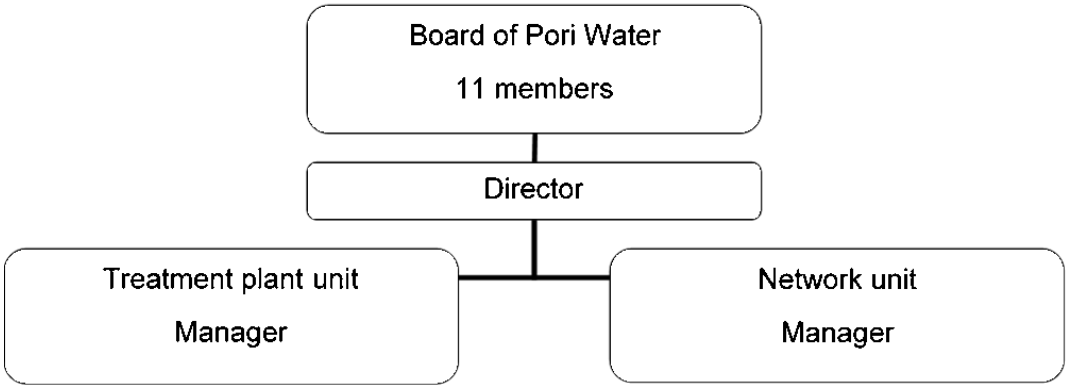

Figure 4.1 Organisation structure of Pori Water in 2013 (adapted from Porin Vesi 2013, 3).

In 2004 Pori Water supplied water to about 76 100 inhabitants and treated their wastewater along with the wastewater of several companies. The area of operation was larger in 2013 than it was in 2004, since new municipalities and co-operatives were connected to the water mains and sewers (Figure 4.2). In 2013 Pori Water supplied water to about 83 500 inhabitants, which was about 10 percent higher than in 2004. The mission of Pori Water is 'to provide water and wastewater services at a competitive price taking into account customers' needs and environmental sustainability'. The mission statement has remained the same during these years.

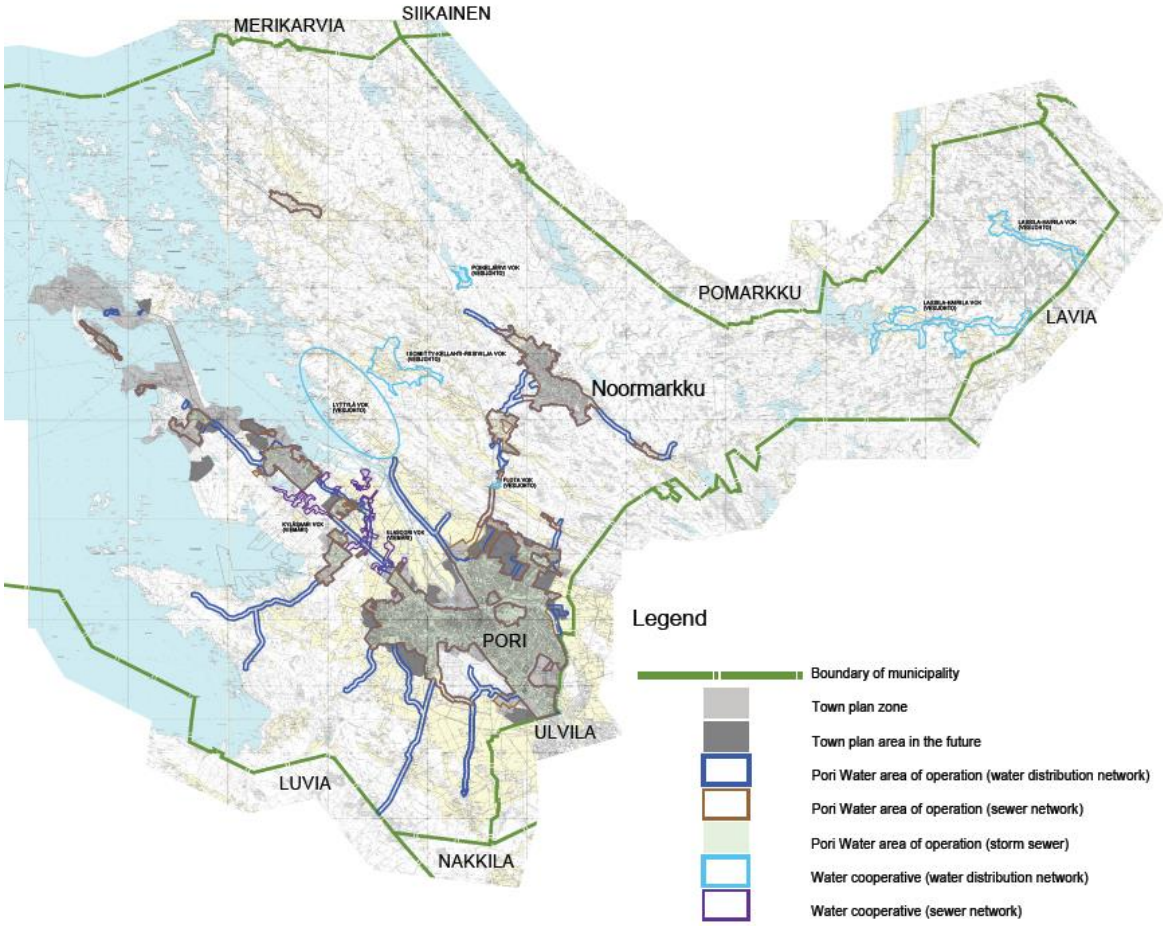

Figure 4.2 Pori Water area of operation in 2013 (adapted from Porin kaupunki 2011).

The 2004 financial statements of Pori Water show that the turnover was 11.9 million euros, with a return to the City of Pori of 1.7 million euros and a profit of 2.5 million euros. In 2013, the turnover was 19.9 million euros, with a return to the City of Pori of 2.2 million euros and a profit of 0.8 million euros (Porin Vesi 2004, 11−13; Porin Vesi 2013, 12−13). The turnover increased from 2004 to 2013 by 67 percent, and the return from the turnover decreased from 14 percent to 11 percent.

From 2004 to 2013, one small wastewater treatment unit in Pihlava closed, and in 2013 the Pori Water utility had seven drinking water units (Harjakangas artificial ground water plant, Lukkarinsanta surface water plant, Vähärauma ground water plant, Huntsman Pigments Oy surface water treatment plant, Ahlainen ground water plant, Kangas ground water plant, and Noormarkku ground water plant), one main wastewater treatment unit in Luotsinmäki, the extension of which was completed in 2010, and small wastewater treatment units in Reposaari and Ahlainen. Harjakangas water treatment plant was the main treatment utility, pumping 96 percent of all drinking water into the

network area of Pori Water. Several package wastewater treatment units were also maintained by Pori Water even though they were owned by the City of Pori.

New water distribution and sewer networks were constructed every year, and the total length increase between 2004 and 2013 was about 35 percent in the water network and about 32 percent in the sewer network. The amount of pumped water to the network and the amount of treated wastewater varied annually. The variations depended mainly on changes in local industries, water usage in industrial processes and wastewater discharges. The key statistical data of Pori Water is shown in Table 4.1.

Table 4.1 Selected characteristics of Pori Water 2004−2013 (Porin Vesi 2004−2013).

Year	Personnel	Citizens served	Water pumped to network, 1,000 m^3/a	Water network, total length, km	Sewerage network, total length, km	Treated wastewater, 1,000 m^3/a
2013	70	83,525	6,264	711	914	11,330
2012	73	83,292	6,396	707	907	13,630
2011	75	83,165	6,097	702	899	13,406
2010	77	83,054	6,797	660	860	9,594
2009	80	76,627	6,021	555	750	7,850
2008	83	76,426	5,544	549	730	10,310
2007	83	76,234	5,948	542	720	9,433
2006	88	76,182	6,576	538	710	9,100
2005	95	76,144	5,794	534	701	11,061
2004	94	76,154	6,499	528	693	10,076

The personnel of Pori Water were distributed among two units performing the main functions of the utility. Vital services, like accounting and payroll services were purchased in 2004 from Pori Energia Oy (later on Pori Energy). Starting in 2006, accounting and payroll services were shifted from Pori Energy to the treasury of the City of Pori. In 2013, financial administration services were purchased from Kuntapro Oy, which offers administrative services to municipalities and their utilities. In 2004 some of the wastewater network construction works were purchased based on public tenders, and some of the transport activities were outsourced. In 2010, cleaning services were also outsourced.

The tasks of the treatment unit and network unit were the same in 2004 and in 2013. The treatment unit was responsible for both drinking water treatment and wastewater treatment. The tasks of the unit also included planning, operation, maintenance, renovation, and building of water treatment plants, groundwater treatment plants, booster stations, water towers, and wastewater treatment plants. Its tasks included water and wastewater quality surveillance in all parts of the water systems from the raw water source to the final discharging point. Sludge treatment and disposal were also among the tasks (Porin Vesi 2004, 5, 9−11; Porin Vesi 2013, 3). The network unit included several task groups: surveying and field investigation, planning operation, maintenance, renovation, and

building of water mains, sewers and pumping stations, maps of mains and sewers, customer services and billing, building and renovation of customer commissioned connections, material and spare-part services, storage, and on-call duty (Porin Vesi 2004, 5−8; Porin Vesi 2013, 3).

Between 2004 and 2013 Pori Water personnel had experienced many changes because of retirement, changes in work positions, outsourcing of tasks, termination of employment contracts, and new recruitments. The number of personnel in 2013 was 70, while in 2004 it was 94. These figures show a decrease of almost 26 percent in nine years. At the same time the service area of Pori Water extended, and the number of citizens served increased.

Both in 2004 and 2013, the knowledge resources of Pori Water consisted of both explicit and tacit knowledge. The amount of knowledge collected and analysed daily was huge. Data and information were gathered on water and wastewater treatment plants, water mains, water towers, sewers, pumping stations, operation and maintenance figures, problems encountered, water quality analysis, chemicals used, electricity consumption, financial management, personnel, customers, and the store, etc. In 2004 there was no formally established quality, environment or safety system at Pori Water, but in 2013 quality management systems and quality policy were in use. A centralised knowledge management system was under construction, and the Tekla Xpipe water and wastewater network information system design application was taken into use at Pori Water in 2004. Tekla Xpipe (Trimble NIS in 2013) is a product especially designed for water and wastewater network documentation and operation, maintenance management, simulation and calculations, and customer service.

Pori Water webpages are part of the website for the City of Pori. The webpages of Pori Water contain a lot of information freely available in Finnish. The website offers an extensive information package on four main topics: customer services, treatment processes and networks, information bank, and Pori Water in brief. The customer services section contains information on charges, networks connections, change of ownership of a connection, commissioned services, water metering, billing, and 24-hour services. One can click on an icon of the Pori Water customer newsletter, *Makea vesi*, (unofficial translation, Fresh water), which links to its digital publication. The customer newsletter was published for the first time in 2011. Customers cannot communicate with Pori Water through any social media platforms.

On the webpages, the sections dealing with treatment processes and networks describe the water treatment process, the wastewater treatment process, and water and sewer networks. From the information bank, customers can see and download water services development plan and annexes, contractual conditions, general supply conditions, research reports on two lakes, Joutsijärvi and Tuurijärvi, and advice on how to operate in case of a sewer malfunction. The information bank also includes guidance on sewer use, and frequently asked questions. The section ’Pori Water in short’ includes the basic information about the public utility. The latest annual report is linked to these pages.

4.2 Background information on the personnel

4.2.1 Personnel groups in 2004 and in 2013

The number of interviewed employees in 2004 was 61 and 33 in 2013. Within this timeframe the total number of employees at Pori water downsized from 94 to 70. The ultimate staff level reduction was 26 percent. The main reason for the high decrease in the personnel was retirement. The percentage of interviewed employees in 2004 and 2013 was 65 and 47, respectively. Altogether, 26 of the interviewees in 2004 (43%) were interviewed again in 2013. The group of interviewed persons in 2013 included seven new employees in the following personnel groups: administrative staff (two), planning officers (three), laboratory workers (one), and storekeepers (one). Background information of the interviewees was collected through questions 1−9.

In 2004 forty interviewed persons were from the Ulasoori unit, 12 from the Harjakangas unit, eight from the Luotsinmäki unit, and one from the Lukkarinsanta unit. For the analysis, Lukkarinsanta was combined with Harjakangas because organisationally both deal with water treatment. In 2013, the locations of interviewed participants were: 22 persons at the Ulasoori unit, five at the Luotsinmäki unit, and six at the Harjakangas unit.

In 2004 and in 2013 the interviewed personnel were grouped into categories based on their tasks (Table 4.2). Task-based grouping described the characteristics of the work performed better than job title-based grouping. The following approaches were applied in the grouping:

- *both in 2004 and in 2013 the top managers, i.e. director and managers of the treatment unit and network unit, were grouped into the category of 'Administrative staff'*
- *the category of 'Planning officers'" consisted in 2004 of the planning officers, plant engineers and project engineers. In 2013, planning officers, plant engineers, construction engineer, and ICT specialists belonged to the category of 'Planning officers'*
- *secretaries, and invoice clerks formed the group of 'Secretaries' in 2004, while in 2013 management assistant, client secretaries, and office secretaries belonged into this group*
- *in 2004 the 'Other technical personnel' group had planning assistants, network mapping assistants, and surveyors, and in 2013, only sewer surveyor*
- *the 'Cleaners' group did not exist in 2013, due to outsourcing.*

Table 4.2 Groups of the interviewed personnel in 2004 and in 2013 at Pori Water.

Personnel category	2004	2013
Administrative staff	3	3
Planning officers	7	6
Secretaries	9	6
Foremen	5	4
Plumbers	6	2
Fitters	4	3
Operators	4	4
Plant workers	7	1
Other technical personnel	7	1
Laboratory workers	3	2
Cleaners	3	0
Storekeepers	3	1
Total	61	33
Percentage of the whole personnel	65	47

4.2.2 Profile of interviewees

In 2004 altogether 30 percent of the interviewees at Pori Water were female and 70 percent male. All secretaries, laboratory workers and cleaners were female. Of the administrative staff, one was female, and of the other technical employees two were female. In 2013 the share of females was 27 percent and males 73 percent. All secretaries, both laboratory workers and one of the plant engineers were female, all others were male. The gender distribution is shown in detail in Table 4.3.

Table 4.3 Gender distribution of the interviewees at Pori Water in 2004 and in 2013.

Interviewee groups	2004 Female	2004 Male	2004 Total	2013 Female	2013 Male	2013 Total
Administrative staff	1	2	3	0	3	3
Planning officers	0	7	7	1	5	6
Secretaries	9	0	9	6	0	6
Foremen	0	5	5	0	4	4
Plumbers	0	6	6	0	2	2
Fitters	0	4	4	0	3	3
Operators	0	4	4	0	4	4
Plant workers	0	7	7	0	1	1
Other technical	2	5	7	0	1	1
Laboratory workers	3	0	3	2	0	2
Cleaners	3	0	3	0	0	0
Storekeepers	0	3	3	0	1	1
Total	18	43	61	9	24	33

In 2004 the mean age of the interviewees was 47 years. At the time of the 2004 study, there were three summer trainees, of whom two were adult students. If the three summer trainees, who worked in the laboratory and in maintenance, are omitted, the mean age was 48 years. Thirty-one percent of the workforce were going to be eligible for retirement in five to ten years. However, every personnel group had several people who were going to retire within five years, and all storekeepers planned to retire within three years. In 2013, the mean age of the interviewees was 50 years. Of the entire workforce, 48 percent were going to be eligible for retirement in five to ten years, assuming that they were going to retire at the age of 63. The age distributions in 2004 and in 2013 are shown in Figure 4.3 and the retirement profiles in 2013 in Figure 4.4.

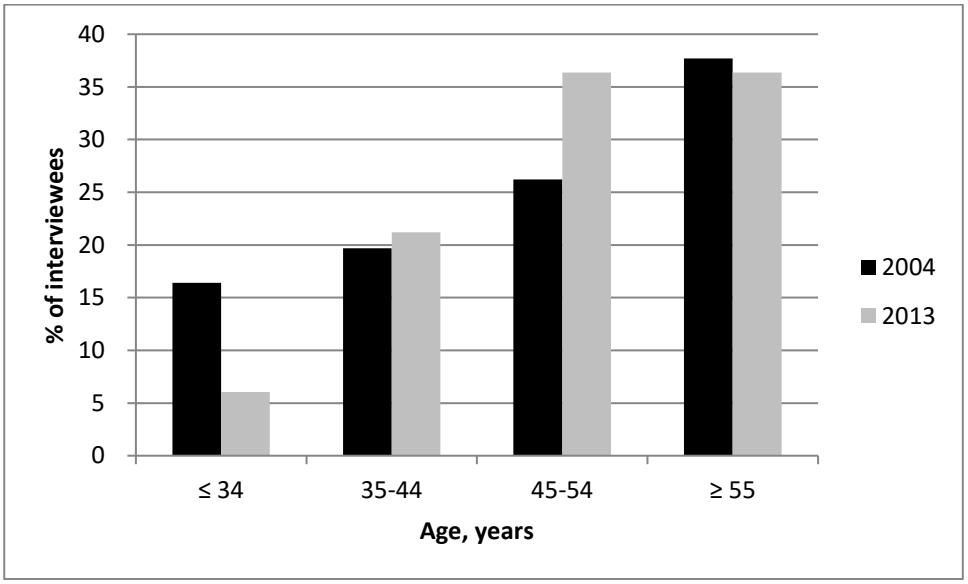

Figure 4.3 Age groups of the interviewees at Pori Water in 2004 (n=61) and in 2013 (n=33).

If the age structure of the interviewees in both 2004 and 2013 are viewed in terms of generational groups, the baby boomers and Generation Yers kept their percentage almost the same, while the proportion of Generation Xers increased. Veterans (also called traditionalists, born before 1945) were no longer among the interviewees in 2013. Detailed statistics were:

- *in 2004: veterans 16 percent, baby boomers 54 percent, Generation Xers 25 percent and Generation Yers five percent*
- *in 2013: baby boomers 55 percent, Generation Xers 39 percent and Generation Yers six percent.*

Both in 2004 and in 2013 the personnel had been working for Pori Water on average for about 19 years. This indicates that employees stay at Pori Water. From 2004 to 2013, 33 percent of the

interviewees had the same job description, 30 percent had slightly different job assignments because of a refocusing of the work, and 15 percent had moved to another position inside Pori Water. At the same time, every fifth interviewee (21%), including the director, had been recruited to the organisation since 2004. Altogether, 71 percent of the new employees had been working at Pori Water less than two years. Figure 4.5 shows the tenure profiles of the employees, i.e. the working experience at the utility.

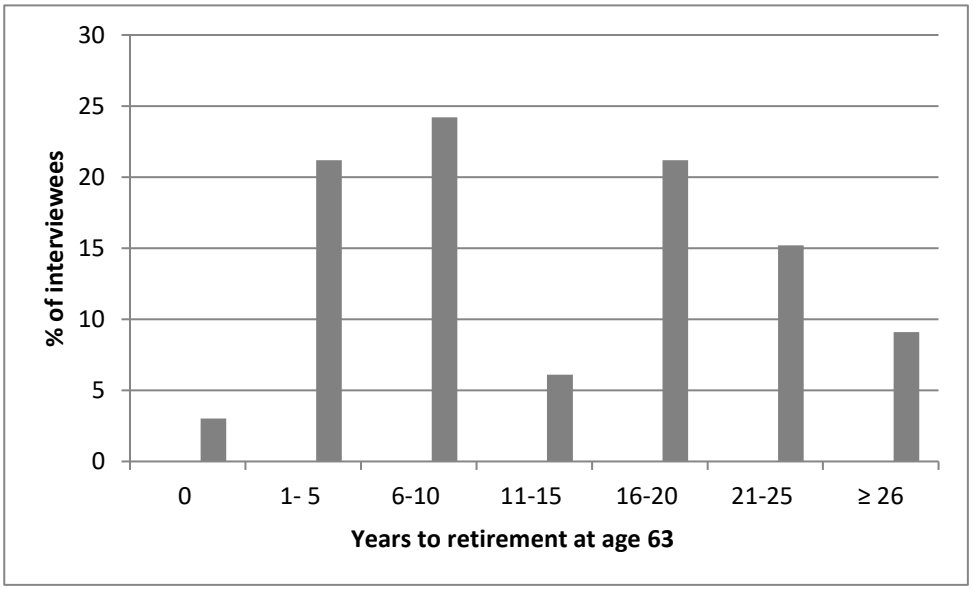

Figure 4.4 The expected retirement profiles of the interviewees at Pori Water in 2013 (n=33).

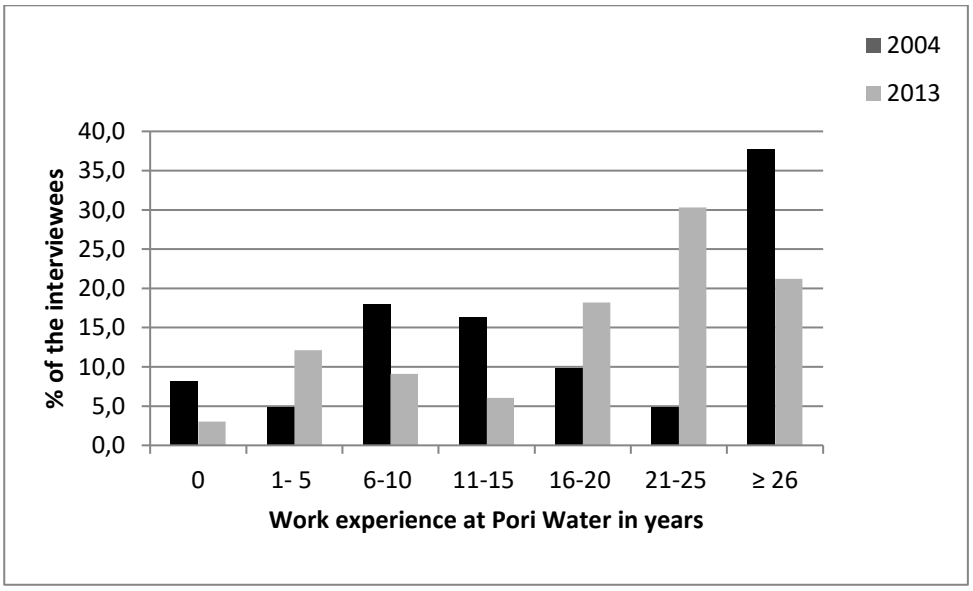

Figure 4.5 Tenure profiles of the interviewees at Pori Water in 2004 (n=61) and in 2013 (n=33).

In 2004 the employees had gained their basic or professional education about 25 years prior (Table 4.4). Of the interviewees, 51 percent had a vocational education, 28 percent had a college education, 6 percent a university education, and 15 percent had no formal education. In 2013, the interviewed employees had gotten their basic or professional education on average 27 years prior. Of the interviewees, 40 percent had a vocational education, 33 percent had a college education, 9 percent a university education, 12 percent a polytechnic (university of applied sciences) education, and 6 percent had no formal education. The figures in 2004 and 2013 are, however, slightly biased because the rest of the personnel, who were not interviewed, either had no formal education or had vocational education.

Table 4.4 Background information on Pori Water personnel in 2004 and in 2013 (some personnel groups have been combined).

Personnel group/ Year	**Age, mean**	**Age, minimum−maximum**	**Years at Pori Water, mean**	**Years at Pori Water, minimum−maximum**	**Degree gained years ago, mean**	**Degree gained years ago minimum−maximum**
Administrative staff						
2004	54	47–59	25	14−31	28	18–34
2013	52	40−60	16	7–23	26	16–36
Planning officers						
2004	47	36–60	17	7–31	18	7–31
2013	44	24–57	9	1–24	16	0–31
Secretaries						
2004	48	34–57	20	0–30	26	1–37
2013	57	47−62	29	16−39	35	20–41
Operators 2004	48	31–58	23	10–35	28	12–40
Operators, laboratory and process analysts 2013	49	38–56	18	1–26	26	14–33
Foremen						
2004	49	37–57	18	6–29	25	16–29
2013	56	46–63	27	6–38	33	25–38
Plumbers 2004	44	35–59	20	6–36	27	17–35
Fitters 2004	49	36–57	21	14–36	32	18–42
Plumbers and fitters 2013	48	42–56	21	15–23	30	25–36
Plant workers 2004	46	23–62	13	0–31	26	2–47
Other technical employees 2004	47	33–60	18	0–39	26	14–43
Plant workers and other technical employees 2013	50	39–63	13	0–25	19	10–37
Mean/range 2004	47	21–62	19	0–39	25	0–47
Mean/range 2013	50	24–63	19	0–39	27	0–41

The educational background of the employees of Pori Water had changed between 2004 and 2013. In general, the personnel had gained more education in 2013 compared to 2004. Within the same time frame, the proportion of employees with vocational education had decreased from 51 percent to

40 percent, and the proportion of employees with no formal education had gone from 15 percent to 6 percent. Polytechnic degree (ammattikorkeakoulu in Finnish) holders had also found their way to the water utility. The top management positions were held by university degree holders in both years. The number of college degree holders will be declining in the future, because in the Finnish educational reform in late 1990s' former colleges were merged into polytechnics.

During the years between 2004 and 2013, a few new tasks had been established in the treatment plants, construction of the utilities, ICT, and operations. Seven of the interviewees were new employees: four of them had been recruited to fill the already existing vacancies and three into newly established vacancies. If the seven new employees, who had been employed outside Pori Water, are ignored, 42 percent (11 persons) had the same tasks as nine years earlier. For 39 percent (10 persons), task areas were slightly larger because of merged activities, and five employees (19 percent) had substantially new job descriptions. These figures indicate the staff's commitment, and the employer's ability to ensure continuity of work for the skilled workers. The downsizing had resulted in a rationalisation of tasks, and had opened new positions for the experienced workforce across Pori Water.

Figure 4.6 presents the employee age plotted by the number of working years at Pori Water among the 2013 interviewees. Tenure-age-plotting is used to identify the possible persons who most probably have critical knowledge. There seems to be a huge concentration of employees with 20 to 30 years of working experience and who are in the 40 to 60 age range. Those employees might have critical knowledge, which should be retained.

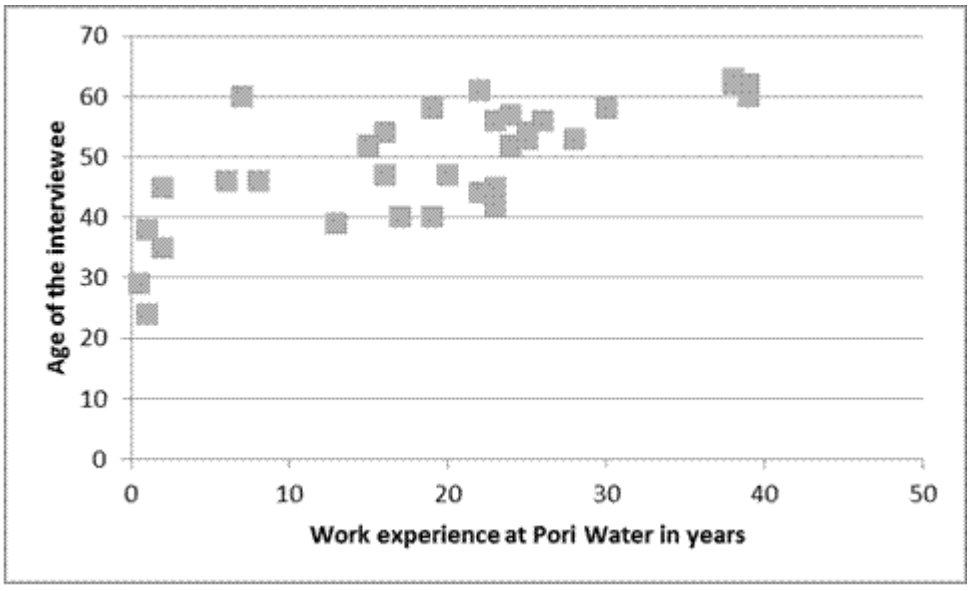

Figure 4.6 The age and length of tenure of the interviewees in 2013 at Pori Water (n=33).

4.2.3 Access to computers and the internet

Questions 10−12 deal with computer and internet connections of the interviewees. In 2004 fifty-six percent of the interviewees had a personal computer and internet access, 6 percent could use a common computer with an internet connection, whereas 38 percent had no personal computer or possibility to use one. In 2013 seventy-nine percent of the interviewees had a personal computer and internet access, 9 percent could use a common computer with internet connection, and 12 percent had no personal computer or the possibility to use one. This development reflects the increased importance of computers and internet access in daily work. Personal computers may not have been needed in all tasks, but access to shared computers was most desirable in many cases. Table 4.5 elaborates the situation with computers and internet connections at various units.

Table 4.5 Computers and internet connections at different units of Pori Water in 2004 and in 2013.

Unit	**Number of interviewed employees**						**Total number of interviewed employees**	
	Personal computer with internet access		**Common computer with internet access**		**No computer**			
	2004	**2013**	**2004**	**2013**	**2004**	**2013**	**2004**	**2013**
Ulasoori	27	16	2	2	11	4	40	22
Harjakangas and Lukkarinsanta	1	6	0	0	12	0	13	6
Luotsinmäki	6	4	2	1	0	0	8	5
Total	34	26	4	3	23	4	61	33

4.2.4 Personnel and training

The interviews included questions related to training possibilities (question 20): training arranged by Pori Water, training organised by other organisations in Finland and training arranged abroad.

In 2004 altogether 69 percent of the personnel annually attended training events arranged by Pori Water, while eight percent attended training events once every two years, two percent once every three years, and three percent once every 6–10 years. Eighteen percent said that they do not attend any Pori Water training events. Employees from all personnel groups except cleaners attended Pori Water internal training events annually. In 2013 altogether 67 percent of the personnel annually attended training events arranged by Pori Water, while three percent attended training events once every two years. Thirty percent said that they do not attend any Pori Water training events. Non-attendants could be found in all personnel groups evenly. The annual training attendance at the Pori Water organised training events was at almost the same level in 2004 and 2013, while the proportion of non-attending personnel rose significantly.

In 2004 thirty-eight percent of the employees of Pori Water annually attended training events organised in Finland by other organisations, 13 percent once every two years, 3 percent once every three or four years, 5 percent once every five years, and 20 percent once every 6–10 years. Altogether 18 percent of the employees did not attend training events organised in Finland. Plant workers (72%), plumbers and fitters (67%), operators (50%), other technical employees (38 percent), secretaries, laboratory workers and cleaners (33%), planning officers (14%), and foremen (20%) attended training events organised in Finland rarely (once every 6–10 years or never). Storekeepers, planning officers, foremen, and administrative staff attended training events more often than other personnel groups. In 2013 52 percent of the employees annually attended training events organised in Finland by other organisations, three percent once every three years, and six percent not even once in five years. Altogether 42 percent of the employees did not attend training events organised in Finland. The attendants were more often from the following personnel groups: administrative staff, planning officers, plant engineers, ICT specialist, secretaries, operators, laboratory and process analysts, and foremen. The figures indicate that both the proportion of annually trained personnel and the non-attending personnel increased between the two years studied. In fact, the non-attending personnel count of 42 percent was rather high. Figure 4.7 shows the training attendance activity in 2004 and in 2013.

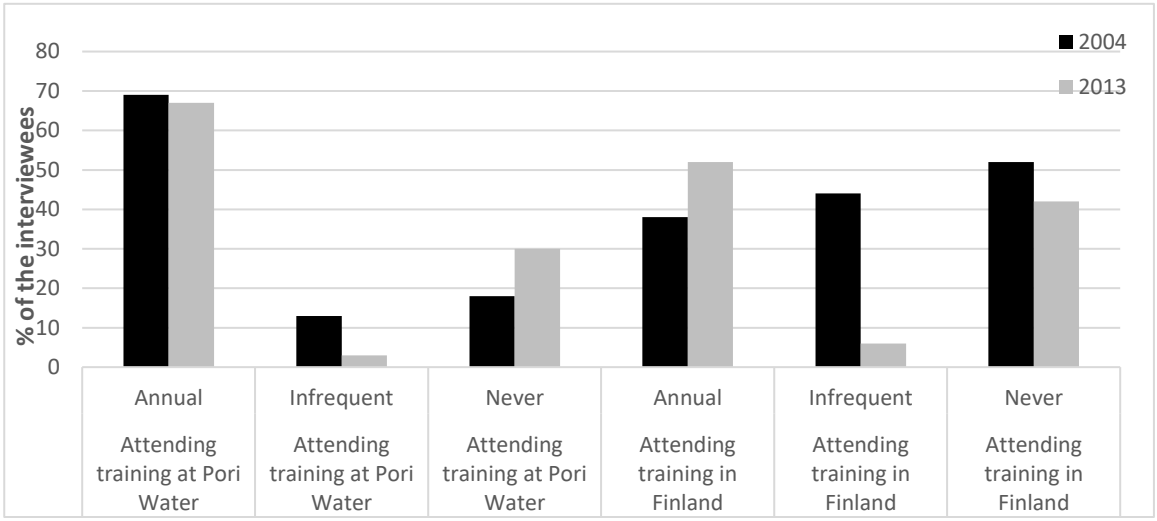

Figure 4.7 Personnel's attendance at training events at Pori Water and training events organised by other organisations in 2004 (n=61) and in 2013 (n=33).

In 2004 training events organised abroad were attended quite seldom: 10 percent attended training courses abroad once every 6–10 years, 5 percent once every five years, 2 percent once every three years while 3 percent attended annually. Eighty percent of the personnel had not attended training events arranged abroad. Planning officers (14%) and other technical personnel (13%) had the

chance to annually attend training events organised abroad. The slump in attending training events abroad was obvious in the 2013 interviews. Only three employees had had a chance to attend international training events organised abroad in the past five years. Ninety-one percent of the personnel had not attended training events arranged abroad.

4.3 Personnel's interpretations of knowledge related concepts

The interviewed employees were asked to freely define four concepts closely related to knowledge (question 27). In 2004 and in 2013 these concepts were presented in the following order: tacit knowledge, information, knowledge management, and information acquisition. In 2013 social media concept was included to the list of questions.

4.3.1 Information

The term *information* was understood in several ways. Information was classified into:

(i) informing

(ii) task-related

(iii) discussions, sharing and disseminating

(iv) general

(v) miscellaneous.

The interviews in 2013 led to the formation of a new category, 'something hidden or not heard'.

In 2004 of the 61 interviewees, 23 (38 percent) equated information with *informing*, that is, receiving information on a certain matter. Most probably, this is a result of the employees' feeling that they did not get enough information about the organisation and its activities. In 2013 only eight (25%) equated information with informing. The personnel were keen to know what is happening at Pori Water. All employees, or at least those whom it concerns, should get such information. Some comments indicated that certain types of information were needed, that is, information that affects their tasks. This kind of information was also received through supervisors.

Already in 2004 the internal information flow was emphasised in many answers. The interviews in 2013 clearly indicated a shift from informing to a smooth information flow. The content and quality of information was regarded highly. The interviewees related the content to their daily work, and the quality to good use of information. Personnel meetings were seen as an excellent way to spread information.

Since 1989 Pori Water has regularly published a personnel bulletin called *Vesiposti*. An online electronic form of *Vesiposti* has replaced the printed version. The bulletin contains news on current projects, personnel, annual financial and performance indicators, legislative issues related to water and the environment, special days and events, and some historical memories, etc. This bulletin was read by almost all the interviewees. Up until 2015 the City of Pori regularly published a personnel bulletin called *Karhunpalvelus*. This bulletin also contained information on Pori Water and its personnel. This bulletin was also read by Pori Water personnel. In 2015 the bulletin was replaced by the online *Jutturumpu*.

In some responses, the following comments were made on information being considered informing:

- *Information bulletins*
- *Information on important issues provided to those who need it*
- *Briefings*
- *Informative meetings*
- *Usable information received*
- *The way information flows.*

Task-related information was typically tied to certain work procedures or to ongoing projects. It is information that should not be held back. Employees could share information with other employees on a voluntary basis, or it had to be dredged up from different sources or databases. In 2004 several answers also emphasised the up-to-date information from planned projects. In 2013 the task-related information was mentioned only twice. This may be explained by the professionally skilled personnel, who have a long working experience of similar tasks at Pori Water.

In some responses, the following comments were made on information being considered task-related:

- *Information on certain tasks, which someone has completed, so that I can do those tasks myself*
- *Information on how to do the work properly*
- *Information delivered from manufacturers.*

The importance of information sharing and disseminating were emphasised in many interviews both in 2004 and in 2013. The daily coffee table discussions were found to be an essential means of getting information in 2004, but in 2013 those discussions were not mentioned once. This can be interpreted in two ways. First, the coffee table discussions are rooted in the information flow processes, so that employees may not see them as a separate means of sharing information.

Second, the hectic working pace might have changed the working culture so that breaks are more formal than in 2004.

Information sharing and dissemination were connected both to Pori Water's internal issues and the information coming from outside the organisation. In 2004 it seemed that the type of information (general, organisational, information on other organisations, personal, task-related, etc.) or delivery means (informal discussions, meetings, via electronic means, printed, etc.) were not considered very important. In 2013 the emphasis was on the direct usability of information.

Both in 2004 and 2013 the most critical issue was that information should be shared with others. In some responses, the following comments were made on information being considered to be discussions, sharing and disseminating:

- *Coffee table discussions*
- *Information provided without asking for it*
- *Information shared on all kinds of matters*
- *Information shared in a way that it does not raise questions*
- *Every now and then disconnected.*

Every kind of information was considered important. Many of the employees wanted to have more information and to filter from the flow the pieces of information they needed. The importance of the information was graded higher in 2013 compared to 2004. In 2013 only one replied that there was too much information. In some responses, the following types of information were considered general information:

- *All kinds of information*
- *Instruction*
- *Spoken, written, heard*
- *Information flowing in through every door; you have to learn to filter the right information from the flow.*

In 2013 information was also understood as something hidden or not heard. Some respondents believed or assumed that others were getting information that they did not. An example of this kind of tacit knowledge is:

- *For some reason there is information I do not hear about.*

This is a rather interesting phenomena, since it relates to formal and informal discussions. In 2013 discussions at coffee breaks or other breaks did not happen as regularly as in 2004, which might indicate that some of the personnel were afraid of missing out on valuable information or knowledge

that was not available in official documentation. It might also be a result of one getting lost in one's thoughts, not listening what other people say, or being afraid that information or knowledge was being shared without them knowing about it. Similar presumptions might be behind the interpretation of hidden information. Some believed that certain information was intentionally being kept out of their reach. An example of this statement is:

- *There is information that is hidden from me, for some reason or another.*

In some responses, the following comments, resembling those on information sharing, were made on miscellaneous information:

- *Easier information, you do not need to work hard to get it.*
- *The whole lifetime is full of information. It would be rather odd to live without information.*
- *Really important if only performed.*
- *You will be in trouble without information.*
- *Better to have more than less of it.*

4.3.2 Information acquisition

Information acquisition was a term clearly understood in both interviews. The following groupings were created from the responses:

(i) individuals actively acquiring information

(ii) information acquired when needed

(iii) various means of acquiring information

(iv) information acquisition for improving skills or performing tasks

(v) miscellaneous.

Individuals who actively acquired information used the internet, books, technical journals, media sources, brochures, personal contacts, etc. to get the information they needed. They were active themselves and spontaneously sought out all possible information sources. In the second group, information was acquired only when there was a real need for it. This type of information acquisition was related to problem solving. There was a knowledge gap that new information could fill. The individuals of this group also actively sought out sources of information and information itself.

Information acquisition was also understood as the means by which information is acquired. The following means were mentioned: personal contacts, the internet, Google, radio, telephone, journals, newspapers, books, correspondence, interviews, education, training courses, seminars,

manufacturers, companies, product presentations, annual reports, other water utilities, and water laws. The role of personal contacts was emphasised in 2004; as high as 75 percent of the interviewees rated this first in their answers:

- *You try to find the information you need from colleagues or the internet.*
- *In one way or another, all communication is information.*
- *If you need information, you call your boss.*
- *Environmental scanning, books, friends, from anywhere.*

In 2013 the role of personal contacts had changed, since only 25 percent used personal contacts first. Seventy percent replied that they try to use all possible paths to find information. The key change between 2004 and 2013 in the ways of information acquiring was towards more individual thinking, problem solving, and using multiple information sources. The use of the internet and Google was emphasised in many answers, but none of the interviewees commented on the validity of information:

- *Today, I can find information from internet.*
- *Google.*
- *Asking and snooping, scanning papers, acting as a detective.*

The task-related information was information by which the workers could make their work easier or increase the quality of the work. This type of information was related to motivation, work procedures, decisions, prices, purchase contracts, etc. Skills improvement was closely related to the tasks and the experiences and skills older colleagues had gained. Some examples of the answers are:

- *For the task, need at the site, solving the problematic case, handling the hard job.*
- *It is still easy today (2004). But when the greybeards retire, then you will be alone and have to think for yourself.*
- *It is highly desirable and absolutely necessary. If the work becomes routine, no new information is acquired.*

The previous comment about the greybeards' retirement and the loss of the support experienced workers gave to other staff members was exemplifies the realisation of this phenomenon in the 2013 replies. Information acquiring has become something to be performed individually in many cases.

The miscellaneous group contained answers related to finding important information out of the information overload. The problem was not the scarcity of information but its quality and validity. In both interviews there seemed to be a thought that some employees try to avoid acquiring new information.

4.3.3 Tacit knowledge

In 2004 tacit knowledge was quite unknown to most of the employees at Pori Water. Some 47 percent of the interviewees had either never heard the term or could not define it. Twenty-three percent said that tacit means that you keep quiet and say nothing even if you know something. The remaining 30 percent could explain the term. When the question was formulated differently, all interviewees understood it to mean the knowledge and skills gained over many years at work. Some employees spontaneously told about situations or instances that revealed the existence of tacit knowledge.

In 2013 as many as 82 percent (27 persons) knew the concept of tacit knowledge without any reformulation, three percent (1 person) did not know the concept, and 15 percent (5 persons) thought it meant that you keep quiet. The concept of tacit knowledge has been dealt with in various sources, both written and broadcast, over the last 10 years. Quite often it has been linked with the retirement boom, with the conclusion that tacit knowledge walks out of the office with the retirement. In regards to the public discussion on tacit knowledge, it is concluded that the personnel at Pori Water have heard the term *tacit knowledge* often since 2004.

Tacit knowledge takes many forms. Based on the interviews, tacit knowledge could be associated with the following:

(i) work experience

(ii) craftsmanship

(iii) co-workers

(iv) something in your head

(v) something not told to anyone

(vi) miscellaneous.

Work experience-based tacit knowledge is knowledge workers have gathered over several years from doing the same tasks. Workers know on the basis of previous tasks, and from their working experience, how they should handle the tasks they are facing. Experiences, trials and errors have developed into tacit knowledge. It is personal, and shared only if someone understands to ask for it. The value of work-based tacit knowledge was considered high and was somehow regarded as being much better than other knowledge. Workers work instinctively to some extent, and as one of them said, they could do the work with their eyes closed. Their work involved some routine phases and the procedures had been developed over the years.

Work experience-based knowledge was described as follows:

- *The kind of knowledge you have gathered at work over 30 years. Knowledge that no-one gives any value. Maybe it will have some value later. It should be shared with others.*

- *It suddenly occurs to you when you see someone at work facing a problem. It develops into a thought, which you process further and finally find the solution.*

- *At the sites and open terrains.*

- *The work is so routine that no younger guy should come and tell me how to do it.*

- *Disappears with the pensioners.*

The personnel of Pori Water felt proud about their good craftsmanship. The basis for craftsmanship-related tacit knowledge was laid in professional training, although the employees valued more the informal, hands-on training during daily work. In 2004 there was no formal vocational education that provided the skills needed to work at a water utility, which is why the role of on-the-job training was of great importance. The formal vocational education on Further Qualification in Water Supply and Sewerage has been available since 2006 and the Specialist Qualification in Natural and Environmental Protection, Specialisation in Water Supply and Sewerage since 2013. These qualification educations have not been utilised at Pori Water. Tacit knowledge based on craftsmanship develops over the years and depends partly on co-workers' willingness to share their tacit knowledge. Craftsmanship was valued as follows:

- *There is not a single problem that the more experienced workers could not solve.*

- *Skills that spurt out at the right moment.*

Many of the workers of Pori Water have held their current jobs for years. The workers and closest team members know each other very well. Workers share tacit knowledge with their closest co-workers, and there is always someone more experienced who can give advice on the tasks. Co-workers' tacit knowledge was described in the following way:

- *I know what the other fellow thinks.*

- *Knowledge that the older co-workers have.*

- *The old men tell it to younger workers; and thoughts are shared.*

- *The employee does not realise how huge the amount of valuable knowledge he has is. Other workers do not grasp it.*

The traditional meaning given to tacit knowledge was expressed in many interviews. For example:

- *It is in your head. You act according to the schemas you have created.*

- *It is self-evident.*

Usually tacit knowledge was understood to be something that is not recorded anywhere else than in your own head. It is the kind of knowledge that cannot be made tangible. It also reflects the development potential of a human being. Two examples of the responses were:

- *It is human information which you cannot define or put on paper. It reflects the development potential of a human being. You inquire about it, and share it further.*
- *It may be milked out.*

The previous citations imply that tacit knowledge is intangible but at the same time transferable to others. That is possible when tacit knowledge is made explicit by doing things together and learning-by-doing.

Interestingly, in 2004 23 percent and in 2013 15 percent of the responses indicated that *tacit* means keeping quiet about matters you know and not documenting or sharing information you have. Some said that tacit knowledge is shared only if someone understands to ask for it. Envy – as a reason for not sharing knowledge – came up in the responses. Also, employees did not all have the same opportunities to get information or to be informed. Some of the comments on the 'do not tell anyone' aspects of tacit knowledge were:

- *Knowledge, which you have, but do not necessary tell anyone, unless they ask for it.*
- *Such behaviour is very common. Especially during holidays when those at work are bewildered. When they have not been told, or someone has not thought of telling them, about some important issues.*
- *Many simply think that there is no need to tell anyone.*

The remaining responses on tacit knowledge were grouped under miscellaneous. These respondents considered tacit knowledge self-evident, not to be found in books, not easily understood information, everyday information, valuable, and actively acquired by oneself. Mainly it was connected to the tasks that were part of work. One of the interviewees said that tacit knowledge has no significance now but will surely be important in the future. The following comments on tacit knowledge were also made:

- *You have to learn to read from the foreman's face his secret wishes and his silent approval of tasks.*
- *Has a negative sound, prevailing practice here.*
- *In many cases worth its weight in gold.*

4.3.4 Knowledge management

In 2004 knowledge management was defined similarly to tacit knowledge; very few knew what it meant. Altogether 38 percent of the interviewed employees said that knowledge management

means informing the personnel. In 2013 15 percent related knowledge management to computers and data management systems, 73 percent said knowledge management is a personal issue, and 12 percent could not give any definition to it. Answers referring to individual property were more prevalent in 2013 than in 2004.

The responses concerning knowledge management were grouped as follows:

(i) individual property

(ii) organisational property

(iii) system information

(iv) miscellaneous.

Almost all of the interviewees indicated that knowledge management is *individually controlled*. The knowledge part was equated with information. Workers utilise their own knowledge in their work and are always eager and ready to learn more. The type of information was emphasised, and information related to practical tasks was valued.

Both in 2004 and in 2013 the management part was associated with personal filing systems – either mental or document filing systems. Most of the interviewees referred to their own memory as the store of information from which they find the needed pieces of information.

Many also said that knowledge management is related to their own work: how well they can perform given tasks, are they sure that they are doing the right things, can they manage their knowledge and use it in the right way. They emphasised that water treatment processes are complicated, and that one should understand what is really happening in the process, not just turn the button routinely. The following are examples of answers about the definition of knowledge management that consider it to be individual property:

- *Difficult to say. I have the know-how. It allows me to find the right things at the right moment.*
- *Knowledge is available, and you find it in your own head, on your own hard disc.*
- *I have it under control. The work goes smoothly, and problems are solved although you work alone.*
- *You should remember what kind of material you have piled on your desk. So that you do not have to start over and over again when you need information on something. You have the material although you do not know where it is. It takes a damned lot of time when you do not manage your material properly.*
- *Craftsmanship; I have it.*
- *You know the theoretical background of the profession, and can do the work in practice.*

In 2004 organisational knowledge management was linked to individual tacit knowledge and information given to customers. Leadership and sharing were new dimensions in the 2013 answers. The meaning of organisational knowledge to the whole organisation was clearly understood, as the following answers show:

- *How could I manage to use the knowledge I have, so that my organisation benefits greatly from it.*
- *We keep the knowledge at the utility.*
- *Leadership needed.*
- *Knowledge disseminated, used and shared.*

System information was the kind of information stored in computers, databases or other media. It included all water and sewer network information, digital maps, decisions made by Pori Water, books, and especially in 2013 product catalogues and online instruction manuals, etc. Two examples of the responses are:

- *It is processed and managed by computers.*
- *It is recorded knowledge.*

Although the responses emphasise stored information as a part of knowledge management, the Tekla Xpipe (Trimble NIS) water and wastewater network information system design application was not seen as a knowledge management tool. It was used only in recording the network data. Miscellaneous replies to knowledge management are related to the superior's power, notes, craftsmanship, and information sharing and receiving.

4.3.5 Social media

The concept of social media was included in the 2013 interviews (question 27 e). Twenty-one percent of the interviewees could not give any definition of the social media concept. More than half of the interviewees (55%) referred to social media as Facebook and Twitter communities. Twelve percent related social media to general information forums, and six percent to newspapers and broadcast news. The remaining six percent said it was unnecessary activity. Some social media answers were:

- *Facebook, Twitter, whatever on earth they are.*
- *Facebook and other communities where you can discuss and change opinions.*
- *Nonsense. Updated webpages will do fine.*
- *No need for that. It's all sorts of tales for younger people.*
- *Small kids' playground.*

Facebook was used by five staff members (15%) in their private life. Two of them used or had used Facebook also in their work at Pori Water. Twitter was mentioned five times, but was not used, and the professional forum, LinkedIn got no mention. The personnel at Pori Water did not give their support to Facebook as a means of informing customers. Updated, real-time webpages and personal telephone services were clearly considered the best way to deliver information to customers.

Having discussed how the personnel at Pori Water interpreted various aspects of knowledge management, the next sub-chapter highlights information needs and acquisition channels.

4.4 Information needs and usage

In the interviews, question 17 dealt with the kinds of information personnel needed in their daily work, and question 18 dealt with the channels from where information was acquired. The latter question also inquired about the frequency of use.

4.4.1 Kinds of information needed in daily work

The personnel needed different kinds of information in their daily work. Some of it was related to decisions on Pori Water and its services, personnel policy, and development. Some was related to terms and conditions of employment and terms of purchase. Legislation was also very important: the water utility must obey laws and regulations in delivering good quality water to its customers and treating wastewaters and discharging them into water bodies. Information needs depended on the tasks the employees were performing. The information needs and changes are shown in Table 4.6 and Table 4.7.

In 2004 more than half of the employees (55%), and in 2013 61 percent, expressed the need for information on decisions made by Pori Water or those made by other organisations concerning Pori Water. Tariff structure, terms of delivery, and contractual terms, were emphasised in many answers. In 2004 administrative staff, storekeepers, secretaries, foremen, and planning officers very often needed information on decisions in their daily work. Cleaners were not interested in this information. In 2013 the situation was the same regarding all previous personnel groups, except that cleaners were not included in the interviews because of outsourcing.

In 2004 information related to terms and conditions of employment and terms of purchase was needed by 33 percent and 44 percent of the employees, respectively. In 2013 both previous information categories collected 55 percent of responses. These figures show that information on terms and conditions of employment and on terms of purchase increased in their importance among the personnel. The purchases have to be performed according to the Public Procurement Act (614/2007), and other rules and regulations. Both in 2004 and in 2013 administrative staff, foremen

and storekeepers needed information on terms and conditions of employment more often than other personnel groups. In 2013 half of the secretaries, operators and laboratory workers and two-thirds of the fitters needed information on terms and conditions of employment. In 2004 plumbers, cleaners, fitters, and operators, and in 2013 plumbers, fitters and other technical personnel did not need information on employment contracts in their work. In 2004 information on terms of purchase was mainly needed by administrative staff, storekeepers, planning officers, laboratory workers, cleaners and foremen. Plumbers and operators did not need this kind of information. In 2013 the situation had remained almost the same; administrative staff, planning officers, storekeeper and foremen were the main users of the terms on purchase. In 2013 new information users on terms of purchase were secretaries (33%), fitters (33%), laboratory workers (50%), and operators (25%). Plumbers, plant workers and other technical personnel did not need this kind of information in their daily tasks.

Table 4.6 Change in the information needs on decisions of Pori Water, terms and conditions of employment and terms of purchase by personnel groups in 2004 (n=61) and in 2013 (n=33) at Pori Water.

Personnel group	**Decisions of Pori Water**			**Terms and conditions of employment**			**Terms of purchase**		
	2004 %	**2013 %**	**Change**	**2004 %**	**2013 %**	**Change**	**2004 %**	**2013 %**	**Change**
Administrative staff	100	100	−	100	100	−	100	100	−
Planning officers	86	83	↓	57	67	↑	86	83	↓
Secretaries	89	83	↓	44	50	↑	44	33	↓
Foremen	80	100	↑	80	75	↓	60	75	↑
Plumbers	17	0	↓	0	0	−	0	0	−
Fitters	33	0	↓	0	67	↑	33	33	−
Operators	25	50	↑	0	25	↑	0	25	↑
Plant workers	43	0	↓	14	0	↓	14	0	↓
Other technical personnel	38	0	↓	13	0	↓	25	0	↓
Laboratory workers	33	0	↓	33	50	↑	67	100	↑
Cleaners (2004)	0	-		0	-		67	-	
Storekeepers	100	100	−	67	100	↑	100	100	−
All	**55**	**61**	↑	**33**	**55**	↑	**44**	**55**	↑

In 2004 all administrative staff, planning officers, and foremen needed information on legislation in their daily work. An average of 58 percent of the employees needed legislative information. Cleaners said that their work had nothing to do with legislative issues. Legislative information had maintained its importance in 2013; 61 percent expressed the need for that type of information. Interviewees mentioned several decrees, for example, the Water Services Act (119/2001), the Water Act (587/2011), the Government Act on Water Resources Management 1040/2006), the Government

Decree on Urban Waste Water Treatment (888/2006), the Government Decree on Treating Domestic Wastewater in Areas Outside Sewer Networks (209/2011), the Chemicals Act (299/2013) and Decree (599/2013), the Environmental Protection Act (713/2014) and Decree (527/2014), the Nature Conservation Act (1096/1996) and Degree (547/2014), the Land Use and Buildings Act (895/1999) and Decree (132/1999), the Employment Contracts Act (55/2001), the Working Hours Act (605/1996), the Occupational Safety and Health Act (738/2002), and the Public Procurement Act (614/2007) and Decree (348/2007). Administrative staff and planning engineers groups needed legislative information, while about half of those from other personnel groups needed this information. Fitters, plumbers, plant workers, and other technical personnel did not express the need for legislative information at all.

Almost all employees (93% in 2004 and 94% in 2013) needed technical information on equipment. In 2004 secretaries needed equipment-related information less than other personnel groups; all of the latter needed this kind of information. In 2013 all personnel, except two members in the group of sectaries, needed technical information on equipment. In both interviews the definition for equipment was very broad: it could be a computer, printer or a machine the employee uses in his/her daily work, or it could be a piece of special process equipment, like a pump, a pumping station, a treatment unit or a network component.

Table 4.7 Change in the information needs on legislation, technical information on equipment and other information by personnel groups in 2004 (n=61) and in 2013 (n=33) at Pori Water.

Personnel group	**Legislation**			**Technical information on equipment**			**Other information**		
	2004 %	**2013 %**	**Change**	**2004 %**	**2013 %**	**Change**	**2004 %**	**2013 %**	**Change**
Administrative staff	100	100	−	67	100	↑	67	100	↑
Planning officers	100	100	−	100	100	−	71	67	↓
Secretaries	89	67	↓	67	67	−	67	33	↓
Foremen	100	50	↓	100	100	−	60	75	↑
Plumbers	33	0	↓	100	100	−	83	100	↑
Fitters	33	33	−	100	100	−	33	0	↓
Operators	50	50	−	100	100	−	25	50	↑
Plant workers	43	0	↓	100	100	−	29	0	↓
Other technical personnel	13	0	↓	100	100	−	63	100	↑
Laboratory workers	67	100	↑	100	100	−	67	50	↓
Cleaners (2004)	0	-		100	-		100	-	
Storekeepers	50	0	↓	100	100	−	33	0	↓
All	**56**	**61**	↑	**93**	**94**	↑	**59**	**61**	↑

In 2004 and in 2013 the interviewees specified a variety of other types of information related to their work (see Table 4.7 column Other information). However, the themes in 2013 were more focused on the performance factors and real-time operational information than in 2004. The needs became more specific, as summarised in Table 4.8.

Table 4.8 Special information needs of the interviewees at Pori Water.

Category of information	**Examples of information**
Decisions	The City Council. The Human Resources Department of the City of Pori. The Procurement Office and the Procurement Council decisions.
Legislation	Changes in legislation.
Technical and technology	Development of technology. Office and professional software updates. Properties of materials. Safety instructions. Vehicles.
Planning and future plans	Future plans. Plans for maintenance activities.
Treatment unit	Function of treatment processes. Laboratory analyses and limit values. Extraordinary situations.
Network unit	Street plans, cables and line (telephone, electricity, district heating) locations. Land use planning and nature preserves. Permission for earth disposal. Field details of water and sewerage network locations. Mapping data. Location of equipment (like water meters) in large blocks of flats. Old pipeline plans and materials. Cleaning agents. Real-time data on leakages. Emergency repair needs (meters, pipeline breakages) indicated by customers. Extraordinary situations.
Personnel	Changes in duties. Sick leave.
Customers	Customer billing. How customers behave or express repair needs.
Stakeholders and other actors	City sector actors' contact details with full address information. Telephone operator. Contractors and construction companies.

4.4.2 Information channels and frequency of use

In 2004 23 percent of the interviewees used personal files or collections daily, 23 percent used them weekly, and 23 percent did not use personal files at all. Administrative staff, planning officers, foremen, secretaries and storekeepers used personal files actively. The biggest groups of personnel who never used personal files were plumbers and fitters (67% in both cases). Half of the other technicians did not use personal files in their work. The document collection at the Ulasoori unit was utilised as a source of information very seldom. Altogether 85 percent of the employees never used that collection. The same applied to local libraries: 84 percent never used them in their work. In 2013 personal files or collections were used daily by 39 percent of the interviewees, 18 percent used them weekly, and 15 percent did not use personal files at all. As in 2004, administrative staff, planning officers, foremen, secretaries and storekeepers used personal files most actively and plumbers and fitters very seldom or not at all. The document collection was not used by 70 percent of the employees, and local libraries were not used in work tasks by 94 percent.

Both in 2004 and in 2013 discussions with the closest co-workers were very frequent: 98 and 91 percent of the interviewees, respectively, had discussions with their co-workers at least weekly, and daily discussions were held by 84 and 82 percent. In 2004 all foremen, cleaners, plant workers and fitters discussed daily with their co-workers. In 2013 foremen, secretaries, fitters, other technical personnel discussed with their co-workers less frequently than other personnel groups, who discussed with their co-workers on a daily basis. When asked about discussions with those other than the closest employees, the answers in 2004 and 2013 were divided more widely between different options: 20 and 15 percent had discussions once per week, 18 per and 0 percent once per month, 15 and 15 percent daily, 13 and 12 percent a couple of times per month, 13 and 15 percent a couple of times per week, 10 and 24 percent a couple of times per year, and 11 and 18 percent never. In both interviews discussions with other water utility personnel were held quite seldom. In 2004 43 percent and in 2013 45 percent had contact with personnel from other water utilities a couple of times per year. Forty-eight and 39 percent had no contact with personnel from other water utilities in 2004 and in 2013, respectively. In 2004 administrative staff, storekeepers, foremen, planning officers, and operators contacted personnel from other water utilities more actively, while in 2013 administrative staff, foremen, laboratory workers and planning officers contacted other water utilities more actively. Other personnel groups had either no contact or very little contact.

Contact with colleagues or other experts outside Pori Water varied greatly. In 2004 foremen (20%), planning officers (14%), and secretaries (11%) had daily discussions with personnel from other organisations. None of the personnel groups had daily contact with personnel from other organisations in 2013. In 2004 all operators, 83 percent of the plumbers, and 71 percent of the plant workers never had contact with experts outside Pori Water, while in 2013 only other technical personnel belonged to this group. In 2004 altogether 34 percent of the interviewees had monthly contact with other experts, 13 percent contacted other experts a couple of times per year, and 18

percent contacted other experts at least once per week. In 2013 these figures were 24 percent, 18 percent, and 30 percent, respectively.

Figure 4.8 shows the frequency of usage of personal files or collections and discussions held between various employees at Pori Water, at other water utilities and experts outside Pori Water.

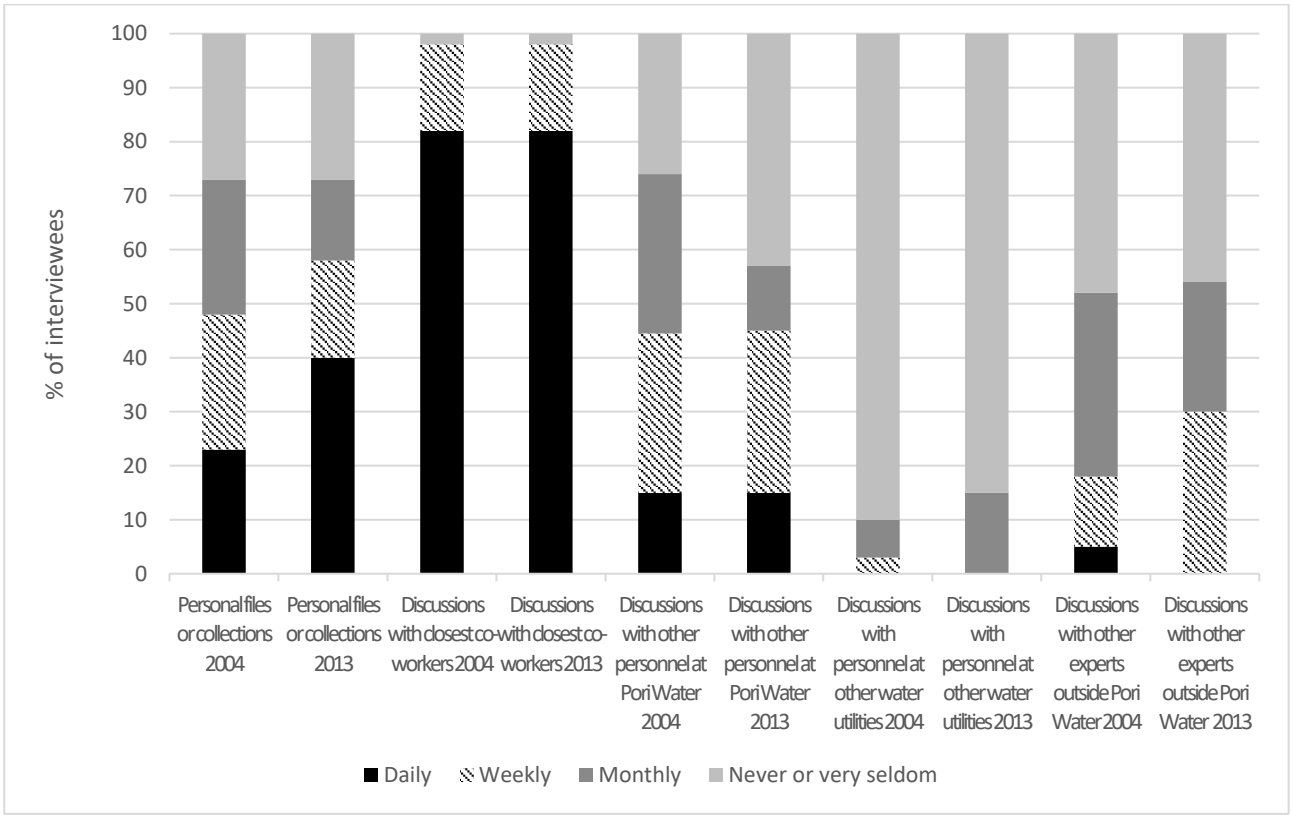

Figure 4.8 The usage of personal files or collections, discussions with closest co-workers, with other personnel at Pori Water, with personnel at other water utilities and with other experts outside Pori Water in 2004 and in 2013.

Considering the entire utility, the use of technical journals and professional books to facilitate work was rather minor: in 2004 61 percent of the interviewees did not use technical journals, and 59 percent did not use professional books in their work. In 2013 the figures were 79 and 70 percent, respectively. In 2004 technical journals were used once or a couple of times per month by 25 percent and professional books by 15 percent, while in 2013 the usage figures were 12 and 15 percent, respectively. In 2004 20 percent of the foremen used technical journals once per week, while 33 percent of the storekeepers used a technical journal a couple of times per week. As for professional books, 33 percent of the storekeepers used one daily, while 29 percent of the planning officers used one once per week. In 2013 33 percent of the administrative staff, 33 percent of planning officers and

25 percent of foremen used technical journals once per month. Other personnel groups did not use technical journals. Seventeen percent of secretaries and 25 percent of foremen used professional books once or a couple of times per week. In the planning officers group 50 percent used professional books a couple of times per month, and 17 percent once a month. Fifty percent of laboratory workers used professional books once per month. Other personnel groups did not use professional books in their work. Similarly, the use of Pori Water internal reports and conference reports was minor. Internal reports were used a couple of times per month in 2004 by eight percent and in 2013 12 percent. Conference reports were used daily by two percent in 2004, by no one in 2013, in 2004 a couple of times per month by no one and in 2013 by three percent.

In 2004 55 percent and in 2013 61 percent of the interviewees never used external reports, that is, reports created by organisations other than Pori Water. In 2004 external reports were used monthly by 25 percent, and 20 percent used them a couple of times per year, while in 2013 these figures were 12 and 18 percent, respectively. In 2004 administrative staff (33%), planning officers (14%), foremen (20%), secretaries (22%), and plant workers (14%) used external reports a couple of times per month. Other technical employees used external reports once per week. Plumbers, laboratory workers, cleaners, and fitters did not use external reports at all. In 2013 67 percent of administrative staff and 25 percent of operators used external reports once per month, 33 percent of planners used external reports once or a couple of times per week, 17 percent of secretaries used them once per month, and 50 percent of the laboratory workers a couple of times per month. Foremen, fitters, plumbers, store keepers, plant workers and other technical personnel did not use external reports.

Equipment manuals and brochures were used weekly by seven percent of the employees in 2004 and nine percent in 2013. Storekeepers used equipment manuals and brochures more often than other personnel groups; 66 percent of the storekeepers used them weekly in 2004 and 100 percent daily in 2013. In 2004 some 26 percent of the other technical employees used equipment manuals and brochures weekly, while in 2013 the usage was zero. In 2004 equipment manuals and brochures were used daily by storekeepers (33%), foremen (20%), plant workers (14%), and planning officers (14%). In 2013, besides storekeepers, the equipment manuals and brochures were used daily by foremen (25%) and administrative staff (33%). Seventy-seven percent of the fitters, 44 percent of the secretaries, 33 percent of the laboratory workers and cleaners, 29 percent of the plant workers, 25 percent of the operators, and 13 percent of other technical personnel did not need equipment manuals and brochures at all in 2004. In 2013 only secretaries, fitters, plant workers and other technical personnel did not need manuals or brochures.

In 2004 only two percent of the secretaries read Pori Water notices and bulletins daily. Other personnel groups read them quite seldom. Notices and bulletins were read once per week by planning officers (29%), administrative staff (33%), other technical personnel (13%), and secretaries (11%). In 2004 36 percent of all employees read notices and bulletins monthly and 30 percent a couple of times per year, while 25 percent never read them. In 2013 notices and bulletins were read daily by nine percent of the personnel, 27 percent monthly, and 12 percent a couple of times per

year. Notices and bulletins were read once per week by 17 percent of planning officers, 25 percent of foremen, and 17 percent of the secretaries. Thirty-six percent of the personnel did not read notices or bulletins at all.

In 2004 the intranet of the City of Pori was used at least once per week by 28 percent of the employees, and in 2013 the count was 39 percent. Both in 2004 and in 2013 active users included foremen (80% and 50%, respectively), planning officers (71% and 66%), administrative staff (67% and 67%), and secretaries (44% and 33%). In 2013 intranet users were also found in the following personnel groups: storekeepers (100%), foremen (50%), laboratory workers (50%), and fitters (33%). In 2004 plumbers, cleaners, plant workers, and operators did not use the intranet at all. In 2013 the same personnel groups (except cleaners) and other technical personnel did not use the intranet. Daily users in 2004 and in 2013 consisted of foremen (60% and 25%), administrative staff (33% and 33%), planning officers (29% and 33%), and secretaries (11% and 33%). In 2013 storekeepers used the intranet daily, too. Twenty-seven percent of the interviewees did not use the intranet in 2013.

In 2004 the usage of the internet was two-fold: 43 percent of the personnel used it at least once per week, while 41 percent never used it. The percentages in 2013 were 67 and 27, respectively. In 2004 the shares of daily users were: administrative staff (67%), planning officers (57%), secretaries (44%), foremen (40%), laboratory workers and storekeepers (33%), and other technical personnel (25%). All plumbers, 75 percent of the operators, 71 percent of the plant workers, 67 percent of the cleaners and fitters, 63 percent of the other technical personnel, 20 percent of the foremen, and 11 percent of the secretaries did not use the internet in their work. In 2013 67 percent of administrative staff, 50 percent of planning officers, 50 percent of foremen, 67 percent of secretaries, all laboratory workers and storekeepers, 67 percent of fitters, and 25 percent of operators used the internet in their work. Plumbers did not use it at all. In 2004 chat channels or discussion forums were used only by the administrative staff – 33 percent used them a couple of times per year. In 2013 administrative staff used chat channels or discussion forums a couple of times per year (67%), and planning officers a couple of times per year (17%) or once per week (17%). Social media communities on Facebook or Twitter were not utilised in daily tasks in 2013.

The usage of the intranet of the City of Pori and the internet at Pori Water is shown in Figure 4.9.

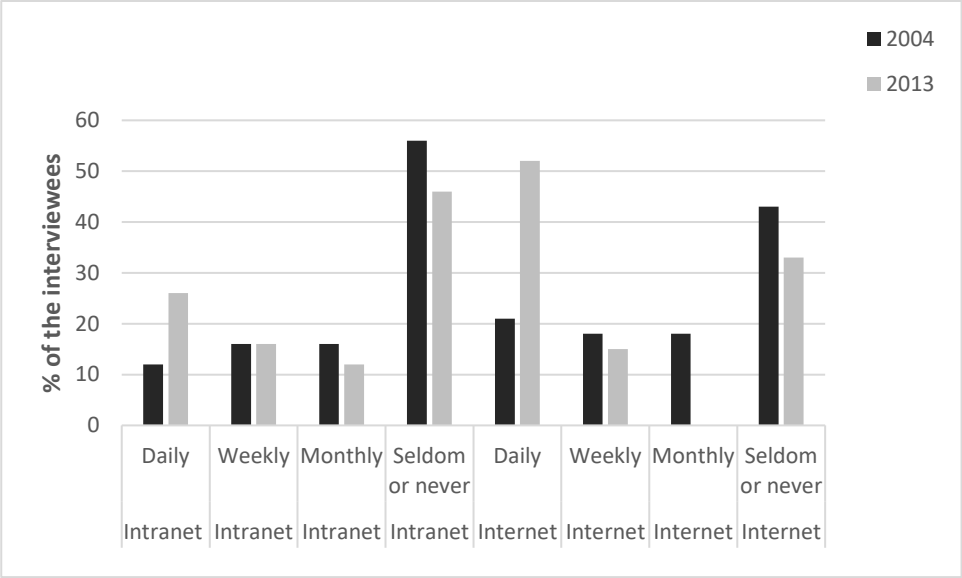

Figure 4.9 Usage of the intranet of the City of Pori and the internet at Pori Water in 2004 (n=61) and in 2013 (n=33).

Standards were used as an information source rather seldom. In 2004 they were used daily by laboratory workers (33%) and secretaries (22%), or a couple of times per week by secretaries (33%). Planning officers (14%) and foremen (20%) used standards once per week. Foremen (40%) and planning officers (43%) used standards once per month. Fifteen percent of the employees used standards a couple of times per year, while 66 percent never used them. In 2014 only administrative staff, planning officers, and laboratory workers used standards in their work. All other personnel groups did not use standards (total share 82%). Thirty-three percent of administrative staff and 17 percent of planning officers used standards once per month. A couple of times per year, standards were used by planning officers. Laboratory workers needed standards either daily (50%) or a couple of times per week (50%).

The role of patents as an information source was infinitesimal. In 2004 33 percent of the administrative staff and 29 percent of planning officers used them a couple of times per year. In 2013 33 percent of administrative staff used patents a couple of times per year, and 17 percent in the group of planning officers, and 25 percent of foremen used patents daily. In both interviews other personnel groups did not use patents in their work.

In 2004 electronic databases were daily utilised by foremen (60%), planning officers (43%), administrative staff (33%), and other technical personnel (25%). This constitutes 15 percent of all employees. In addition, seven percent of the employees used electronic databases a couple of times per week: 33 percent of the administrative staff, 14 percent of planning officers, 20 percent of the foremen, and 11 percent of the secretaries. Thirty-three percent of the laboratory workers and storekeepers, and 11 percent of the secretaries, used electronic databases a couple of times per

month. The share of those who used electronic databases a couple of times per year was 5 percent, while the share of those who used them a couple of times per year was 10 percent. Altogether 64 percent of the employees did not use electronic databases in their work. This group consisted of all personnel groups except for foremen. Plumbers, cleaners, plant workers, fitters, and operators did not use electronic databases at all.

In 2013 all foremen, 50 percent of plumbers, 33 percent of administrative staff, 33 percent of fitters, 17 percent of planning officers, and 17 percent of secretaries used electronic databases daily. Those who used electronic databases a couple of times per week were in the personnel groups of laboratory workers (50%), administrative staff (33%), and planning officers. Those who used them once per week were in the planning officers group (17%). Electronic databases were used less frequently by planning officers (a couple of times per month by 17%) and by secretaries (once per month by 17%). Twenty-seven percent of all staff members used electronic databases daily, 9 percent used them a couple of times per week, 3 percent used databases once per week, 3 percent once per month, and 3 percent a couple of times per month. Electronic databases were not used by 55 percent of all employees. All storekeepers, operators, plant workers and other technical personnel did not use electronic databases at all.

Other information sources were used in 2004 by 10 percent, and in 2013 by 15 percent of all employees. Among these sources were local newspapers, personnel bulletins published by the utility (*Vesiposti*) and the City of Pori (*Karhunpalvelus*), scrapbooks, i.e. collections of materials, stories, events, etc. dealing with Pori Water, monthly meetings of other city organisations, former employees when they visited the utility, the business information system (online), the Teamware email system, and calls to various experts.

The question on social media was added in the 2013 interviews. The role of social media as a communication channel was found to be non-significant. Only six percent had used social media once or a couple of times in a year, while 94 percent had not used it in their daily tasks.

Table 4.9 summarises the changes in the use of information channels among all interviewed staff members at Pori Water between 2004 and 2013.

Table 4.9 Changes in the use of information channels at Pori Water between 2004 (n=61) and 2013 (n=33). Usage activity is described in three categories, i.e. information channels used daily, information channels used weekly or once or a couple of times per month, and information channels never used or used a couple of times per year. Percentages indicate the proportion of interviewees in each category.

Information channel	**Daily users**			**Weekly users and once or a couple of times per month users**			**Non-users and a couple of times per year users**		
	2004 %	2013 %	Change	2004 %	2013 %	Change	2004 %	2013 %	Change
Personal files/collections	23	39	↑	49	33	↓	28	27	↓
Library/document collection of Pori Water	0	6	↑	8	23	↑	92	73	↓
Local libraries	2	0	↓	3	0	↓	95	100	↑
Discussions with closest co-workers	82	82	−	16	12	↓	32	6	↓
Discussions with other staff members at Pori Water	15	15	−	64	43	↓	21	42	↑
Discussions with personnel of other water utilities	0	0	−	10	15	↑	90	85	↓
Discussions with other experts outside Pori Water	5	0	↓	47	55	↑	48	45	↓
Technical journals	0	0	−	28	12	↓	72	88	↑
Professional books	3	0	↓	18	21	↑	79	79	↑
Pori Water internal reports	7	3	↓	36	30	↓	57	67	↑
External reports (outside Pori Water)	0	0	−	26	21	↓	74	79	↑
Conference and seminar papers	2	0	↓	10	15	↑	88	85	↓
Equipment manuals and brochures	7	9	↑	46	39	↓	47	52	↑
Pori Water notices/bulletins	2	9	↑	44	42	↓	54	49	↓
Intranet of the City of Pori	11	21	↑	33	36	↑	56	43	↓
Internet	26	52	↑	28	15	↓	46	33	↓
Standards	5	3	↓	15	9	↓	80	88	↑
Patents	0	6	↑	0	0	−	100	94	↓
Electronic databases	15	27	↑	11	18	↑	74	55	↓
Chat channels, discussion forums	0	0	−	0	3	↑	100	97	↓
Others	10	15	↑	13	6	↓	77	79	↑

4.5 Networks of Pori Water

Questions on trade union and professional association memberships in Finland (question 21) and abroad (question 22) were asked to establish a picture of the networks at Pori Water. Questions about whom the interviewees contacted at Pori Water when problems arose, either in their work (question 23) or when seeking professional information (question 26), were asked to establish the task-related internal and external networks.

4.5.1 Professional association and trade union memberships

Pori Water is a member of the Finnish Water Utilities Association (FIWA, http://www.vvy.fi/), which in turn is a member of the European Federation of National Associations of Water Services (EurEau, http://www.eureau.org/) and a corporate member of the International Water Association (IWA, http://www.iwa-network.org/). FIWA is a co-operation association for Finnish water and wastewater utilities. They provide a variety of services, such as promoting water regulation interests in Finland and the European Union, organising training, creating guidelines and publications, and offering advice and guidance to their member utilities (FIWA webpage 2016).

In 2004 professional association memberships attracted only 10 percent of the interviewees. Three of the planning officers and four of the foremen had contact with professional associations. Only one employee was a member of two different professional associations. These professional associations were Kuntien Putkimestarit (Finnish Pipe Masters Municipal Association, four employees), Suomen LVI-liitto SuLVI ry (The Finnish Association of HVAC (Heating, Ventilation and Air Conditioning) Societies, one employee), Kunnossapitoyhdistys ry (the Finnish Maintenance Society, one employee), and Suomen Automaatioseura ry (the Finnish Society of Automation, one employee). Associations directly related to water or environmental issues were missing from the employees' networks. All interviewees except four were members of trade unions. Only the chief shop stewards were actively involved *ex officio* in trade union activities. Others were inactive members.

In 2013 membership in professional associations attracted only six percent of the interviewees. One employee from the group of foremen and one from laboratory workers had contact with professional associations. Water or environmental associations and international associations were non-existent in 2013 as well. Only two of the interviewees (6%) were also members of professional associations related to their work. One foreman was member of Kuntien Putkimestarit KPM ry (Finnish Pipe Masters Municipal Association), and one process analyst was a member of Suomen Laboratorioalan Liitto ry (unofficial translation: Laboratory Workers in Finland). Table 4.10 provides a general overview of professional association membership at Pori Water. None of the Pori Water personnel were individual members of international associations in 2004. The situation remained the same in 2013.

Table 4.10 Professional association and trade union membership at Pori Water in 2004 and in 2013.

Contact type	**Group or organisation 2004**	**Span 2004**	**Group or organisation 2013**	**Span 2013**
Water utility association	FIWA	National	FIWA	National
Professional association	Four professional associations	Regional, national	Two professional associations	Regional, national
Trade union	13 trade unions	Local, regional, national	11 trade unions	Local, regional, national

Professional association membership is not obligatory in Finland, neither is trade union membership. However, employees join trade unions because trade unions offer security in regards to workplace disputes, unemployment benefits and other services, like professional literature, training courses and networking. In 2004 the employees at Pori Water had membership in altogether 13 trade unions, while in 2013 the number was 11. Worth noting, both in 2004 and in 2013, is that none of the interviewed personnel mentioned contacting trade unions or professional associations when they had professional problems at work. Membership was obtained only to assure support in case of disputes with their employers or for unemployment benefits. Four of the interviewees (7%) in 2004 and three (9%) in 2013 did not belong to any trade union. The trade union membership identified at Pori Water are presented in Table 4.11.

The most surprising outcome of the networks of Pori Water was that work-related professional association membership did not attract personnel in 2004 or in 2013. Only a few were members of professional associations, which paralleled with their occupation beyond the water sector. In both interviews none of the personnel had membership in international associations. It is possible that memberships in international associations did not spark interest partly because there was no possibility to attend international conferences and partly because of the local nature of water utility. The interviews revealed that personnel did not use trade unions as a source of work-related information. Professional associations' role as a source of work-related information was the least possible.

Table 4.11 National trade union membership at Pori Water in 2004 and in 2013.

Trade union	2004	2013
Julkis- ja yksityisalojen toimihenkilöliitto JYTY (The Federation of Public and Private Sector Employees, JYTY)	4	2
Insinööriliitto (The Union of Professional Engineers in Finland IL)	3	0
Tekniikan ja Peruspalveluiden Neuvottelujärjestö KTN ry (Confederation of Employees in Technical and Basic Service Professions KTN)	1	0
Tekniikan Akateemisten Liitto TEK ry (Academic Engineers and Architects in Finland TEK, English name in 2004 The Finnish Association of Graduate Engineers TEK)	1	1
Kuntatekniikan Akateemiset r.y. Kunta-TEK (unofficial translation Association of Academic Employees in Municipal Technology), (In 2004 Kuntatekniikan Akateemiset KIA, merged into TEK), TEK's member organisation	3	0
Suomen konepäällystöliitto (unofficial translation Finnish Marine Engineer's Association)	1	0
Palvelualojen ammattiliitto PAM (Service Union United PAM)	1	0
Toimihenkilöunioni (Union of Salaried Employees TU)	1	0
Neuvottelujärjestö Tekniikka ja Terveys KTN ry (Confederation of Employees in Technical and Basic Service Professions KTN)	0	2
TEAM Teollisuusalojen ammattiliitto ry (Industrial Union TEAM) (In 2004 Kemianliitto (The Chemical Workers' Union), merged with other unions into TEAM)	1	1
Julkisten ja hyvinvointialojen liitto JHL (The Trade Union for the Public and Welfare Sectors JHL), (In 2004 Kunta-alan ammattiliitto KTV (The Trade Union for the Municipal Sector KTV), merged with other unions into JHL)	31	15
Korkeasti koulutettujen työmarkkinajärjestö Akava (Confederation of Unions for Professional and Managerial Staff in Finland), employee's association, affiliation not specified by the interviewee	0	2
Suomen Rakennusinsinöörien Liitto RIL (Finnish Association of Civil Engineers RIL)	0	1
KTK Tekniikan Asiantuntijat ry (Union of Technical Professionals, KTK), (In 2004 Kuntien tekniset KTK (Confederation of Municipal Employees in Technical Professions KTK)	8	3
Suomen Ammattikorkeakoulu- ja Opistotekniset SKT ry (unofficial translation: Finnish Polytechnic and College Engineers), (In 2004 Suomen amk- ja opistotekniset KT ry), KTK's member organisation	1	0
Tekniikan ja Erityisalojen Ammattilaiset KTL ry (unofficial translation: Technical and Construction Professionals), KTK's member organisation	0	1
Kuntien rakennusmestarit ja –insinöörit AMK KRI ry (Municipal Master Builders and Engineers), KTK's member organization	0	1
KI Insinöörit ry (unofficial translation: Municipal Engineers) (In 2004 Kuntien insinöörit ry KI), KTK's member organization	1	1
Total	57	30

4.5.2 Task-related networks

The other type of networks identified were task-related networks, which were studied further in two continuums, the Pori Water internal network and the network outside Pori Water. The networks are dealt with according to the nature of work. The administrative staff's networks depended on the tasks and units they worked for. In 2004 the networks of the director were large, consisting of various stakeholders, organisations of the City of Pori, and regional and national organisations. The internal network included practically every employee of Pori Water. The external network consisted of City of Pori organisations, like the Public Relations Office, the Health Care Office, the Board of Pori Water, the Board of Environment, the Technical Director of the City of Pori, the Southwest Finland Regional Environment Centre, the most important customers, and FIWA. The new director, hired outside of Pori Water, started the job in 2006. The closest internal network of the director in 2013 consisted of the other administrative staff. The external network consisted of the City of Pori organisations − the Procurement Office, the Environmental Protection Office, the City Treasury, the Technical Services Centre – and the Technical Director of the City of Pori. The Board of Pori Water and the Board of Environment were found of course to be key players in the external network.

In 2004 the manager of mains and sewers administered internal networks with other administrative staff, foremen, planning officers, map drawing personnel, and surveyors. The City of Pori organisations – Pori Energy, the Technical Services Centre (especially the Street Construction Unit), and the Office of Land Use Planning – form the local part of the external network. Colleagues at other water utilities and FIWA were also included in the external network of the manager of mains and sewers. The internal network was almost the same in 2013, since the work is done in close co-operation with other administrative staff and subordinates. The external local network was a bit larger; besides the organisations listed for 2004, there was connection to the Environmental Protection Office and to the City Lawyer. Colleagues at other water utilities were important when consultation in technical issues was needed.

In 2004 the project engineer managed development tasks. The internal network members consisted mainly of other administrative staff. The external network consisted of the Environmental Protection Office of the City of Pori, the Southwest Finland Regional Environment Centre, chemical suppliers, equipment manufacturers, and contractors. This position did not exist in 2013 because the tasks were united with the tasks of manager of the treatment plant unit and the construction engineer.

The other administrative staff members were the key actors in the internal network of the manager of the treatment plant unit in 2004. The external network was large: besides the City of Pori organisations – Pori Energy, the Procurement Office, the Human Resources Office, the City Lawyer, and the Technical Services Centre – there were regional organisations like the Southwest Finland Regional Environment Centre, and the Water Protection Association of the River Kokemäenjoki (KVVY). Contact with colleagues in other water utilities and FIWA were also provided by the external network of the manager of the treatment plant unit. The vacancy of the manager of treatment unit

had been filled internally before the second interview. In 2013 the internal network of the manager of treatment unit consisted mainly of other administrative staff, plant engineers, personnel at treatment facilities and secretaries. The external network was a combination of the above-mentioned 2004 networks of the project engineer and the manager of treatment unit.

When in need of professional information, the head of the water treatment plant relied mainly on the external network which consisted of Turku, Tampere and Vaasa water treatment plant personnel. In 2004 the other actors in the external network were former maritime colleagues. The plant engineer of the wastewater treatment plant was in a similar situation, that is, the external network played a bigger role than the internal network. The plant engineer's external network consisted of former colleagues and chemical suppliers. In 2011 the new employee hired from outside of Pori Water started as a plant engineer in the water treatment plant. In 2013 the wastewater treatment plant internally hired a deputy for a plant engineer. The plant engineer working at the water treatment plant contacted administrative staff and duty officers about the network unit for professional information. The main external network actors were the Health Care Office, engineering companies and contactors in automation, instrumentation and electricity. The internal network of the plant engineer at the wastewater treatment unit consisted of the administrative staff, other personnel at the wastewater treatment facility and the plant engineer at the water treatment plant. Equipment manufacturers belonged to the external network.

In 2004 planning officers contacted other planning engineers, the manager of the mains and sewers, foremen, plumbers, storekeepers, and secretaries of customer service. The network outside Pori Water consisted of City of Pori organisations, like the Technical Services Centre (especially the Street Construction Unit), the Environmental Protection Office, the Information Management Office, and Pori Energy. On the regional level, the network extended to the Southwest Finland Environment Centre. The national level representatives of the planning officer's network were suppliers of pipes and pumps and the software company, Tekla. In 2013 manager of mains and sewers, other planning officers and foremen were the key contact points in the internal network. The representatives outside of Pori Water were mainly the same as in 2004.

In the classification of personnel (Sub-chapter 4.2) the group of planning officers included plant engineers, a construction engineer and an ICT specialist, too. The networks of plant engineers have been dealt with in earlier paragraphs. Vacancies in the positions of ICT specialist and construction engineer were established in 2005 and in 2010, respectively, and filled with employees hired outside Pori Water. Their networks were as follows:

- *ICT specialists' internal network consisted of the manager of mains and sewers, foremen and storekeepers. The external network was based on connections to City of Pori organisations, like the Information Management Office and the Procurement Office, software companies and suppliers;*

- *The manager of mains and sewers, closest co-workers and plumbers were the key actors in the construction engineers' internal network. The external network was*

large, comprising the Technical Services Centre in the City of Pori, contractors, consulting companies, suppliers, manufacturers, and former colleagues.

The networks of secretaries depended on their tasks:

- *In 2004 the director's secretary performed mainly secretarial duties for Pori Water management, meaning that she came mainly into contact with the director and the board members. The external network in Pori consisted of city organisations, the Information Management Office and the Human Resources Office, the Local Register Office and other management secretaries. The national links were with FIWA and the software company, Tekla. In 2013 the position title was management assistant, which implied more challenging tasks. The current position holder was internally hired for the position. Besides the management secretarial duties, preparing budget proposals, reports and organising events were included in the job description. The internal network was the same as in 2004, but the external network was somewhat larger. Pori consisted of city organisations − like the Procurement Office, the City Treasury, the Information Management Office, the Human Resources Office − and KuntaPro Oy (personnel and financial administration service provider) belonged to the external network.*

- *In 2004 the secretaries in billing contacted their superior at Pori Water. Their external links were with the City's Information Management Office, and on the national level, a client information software company. The contacts were the same in 2013 with an additional link to a payment printing company.*

- *In 2004 the clerks who handled payroll computations, purchase invoicing, and invoices for labour contracts also had large networks. Their superior, other secretaries and clerks, foremen, and storekeepers were included in their internal network. Their tasks required contacting city organisations like Pori Energy, the Technical Services Centre, Occupational Health Services, the Information Management Office, the City Treasury, and the City Lawyer. They also had contacts with local and regional contractors. In 2013 the job title was secretary. Besides the tasks in 2004, new tasks included reporting and archiving. Their internal network consisted of superiors and other secretaries. The key contacts outside of Pori Water were KuntaPro Oy, a billing software company, the Information Management Office and Occupational Health Services.*

- *In 2004 the clerks handled water contracts, notices of contract terminations, balances of payments, and collections of payments. Thus, their internal and external networks were large. Internally they contacted their superiors, other secretaries and clerks, foremen, metering and map drawing personnel, and planning officers. The clerks' external network was local except for the software company, Tekla. Local links in their network were Pori Energy, the Construction Supervisors, the Environmental Protection Office, the Collection Agency, the Execution Office, and the Local Register Office. In 2013 the position was customer service secretary. Basically, secretaries handled similar tasks as in 2004. Superiors, foremen and planning engineers and other secretaries were the key persons to whom they turned in need of information. External network included the billing software company, KuntaPro Oy, the Technical Services Centre, Construction Supervisors, the Environmental Protection Office and the Building Control Office.*

In 2004 the foremen's internal contacts were with other foremen, storekeepers, the manager of mains and sewers, and the director. The network outside Pori Water consisted of City of Pori organisations like the Technical Services Centre, the Construction Supervisors, the Information Management Office, and Pori Energy. Other local connections were with building automation systems companies, local teleoperators and locksmiths. On the national level, the foremens' network

consisted of pump manufacturers. In 2013 the internal network was similar to that of 2004, while the external network was expanded to include the local bus company, local police and rescue services, construction companies and contractors.

In 2004 operators had internal networks only at Pori Water. The other operators, their superior, the manager of the wastewater treatment unit, and the manager of mains and sewers were the persons to whom they turned with professional problems. The internal network did not change over the years. The operators said in 2013 that seldom did they have to contact police or rescue services, hospitals, Pori Energy, the dairy (Osuuskunta Satamaito) or the power plant, Fortum Power and Heat Oy.

In 2004 the internal network of laboratory workers consisted of other laboratory workers, their superior, plant workers, operators (of the water treatment plant), the director, and the instrumentation technician. Laboratory workers had a large external network which consisted of the local laboratory, Porilab, the City of Pori's health inspector, suppliers of analysis equipment, reagent suppliers, the Southwest Finland Environment Office, Rauma Water, and Rauma Foodstuffs Laboratory. In 2013 the vacancies related to laboratory analyses and treatment process control were titled as laboratory analyst and process analyst. The latter vacancy was filled internally. Both internal and external networks were large, and an additional contact was the laboratory of the Water Protection Association of the River Kokemäenjoki. Otherwise the networks in 2004 and in 2013 were identical.

The task-related networks of other personnel at Pori Water were the following:

- *In 2004 the plumbers' internal network consisted of other plumbers, foremen, and storekeepers, and the external connection was with the Technical Services Centre of the City of Pori. In 2013 the internal network was the same, but there were no external connections. One of the plumbers was shifted internally to the current vacancy.*

- *A fitter's internal network included other fitters, foremen, and the superior of the metering unit. Various equipment manufacturers – of pumps and water meters – were the core external connections of fitters in 2004. Their internal network in 2013 was quite similar to the one in 2004, i.e. foremen and other fitters. Electric companies and pipe manufacturers were new contacts in the external network.*

- *In 2004 plant workers of the wastewater treatment plant had internal contacts with other plant workers and their superior. Outside Pori Water, the network consisted of City of Pori organisations: The Technical Services Centre and Pori Energy. At the water treatment plant, the workers' internal networks consisted of other plant workers, their superior, operators, laboratory workers, and the on-call duty personnel. The plant workers at the water treatment plant did not have external networks. It should be pointed out that the plant workers at the wastewater treatment plant and water treatment plant did not have mutual contacts. In 2013 the plant worker at the wastewater treatment plant had internal contact with superiors. Contact outside of Pori Water was seldom made to pump manufacturers and to other treatment plants.*

- *In 2004 other technical personnel's networks depended on their tasks. The planning assistants' internal network extended to planning officers, other planning assistants, the manager of mains and sewers, and the surveying unit. They had external*

contacts only with the City of Pori's Information Management Office. In 2004 those who worked for the surveying internally contacted their closest co-workers, fitters, plumbers, and foremen. The surveyors' external network consisted of equipment manufacturers and the Technical Services Centre (Department of Surveys) of the City of Pori in addition to equipment manufacturers and the surveying units. Sewer inspectors' external contacts also included the maintenance company of the sewer camera inspection system and the manufacturer of the sewer camera car. The contacts of a sewer inspector remained the same in 2013.

- *In 2004 a cleaner's internal network consisted of other cleaners and their superior. The external network of cleaners included the Social Welfare Office of the City of Pori's foreman for cleaning works and the local cleaning agent and detergent supplier. Cleaners were outsourced before the year 2013, thus the networks for that time is not covered here.*

- *Other storekeepers, foremen, the manager of the mains and sewers, and the director were included in the storekeepers' internal network in 2004. The storekeepers' external network was singularly large. They had regular contacts with numerous equipment manufacturers, wholesalers, pipe and valve manufacturers, suppliers, etc. The extent of their external network could be explained by the fact that they were responsible for the condition of the pipes, valves, equipment, etc. leaving the store. Storekeepers were also persons to whom other workers turned to when they needed special information on equipment, spare parts, or the properties of materials. In 2013 the networks of a storekeeper, who was hired outside of Pori Water in 2013, was similar to the one of a storekeeper in 2004. In fact, the personnel at the store had retired, and the other employee had started his job in 2006. Based on the interviews it could be concluded that the store was no longer a key venue for unofficial discussions with co-workers.*

The external networks indicate contacts with organisations, associations, companies, groups and persons beyond the boundaries of Pori Water (Tables 4.12−4.14).

Table 4.12 City of Pori local functional unit contacts of Pori Water in 2004 and in 2013.

City of Pori Contact group, organisation or person	**2004**	**2013**	**City of Pori Contact group, organisation or person**	**2004**	**2013**
Public Relations Office	Yes	Yes	Health Care Office	Yes	Yes
Procurement Office	Yes	Yes	Occupational Health Services	Yes	Yes
Collection Agency	Yes	Not available	Technical Director	Yes	Yes
Execution Office	Yes	Not available	Construction Supervisors	Yes	Yes
Information Management Office	Yes	Yes	Technical Services Centre	Yes	Yes
Human Resources Office	Yes	Yes	Office of Land Use Planning	Yes	Yes
City Treasury	Yes	Yes	Environmental Protection Office	Yes	Yes
City Lawyer	Yes	Yes	Building Control Office	Not available	Yes
Social Welfare Office	Yes	Not available	Board of Pori Water	Yes	Yes
Local laboratory, Porilab (since 2015 laboratory is part of KVVY)	Yes	Yes	Board of Environment	Yes	Yes

Table 4.13 City of Pori external corporate entity contacts of Pori Water in 2004 and in 2013.

City of Pori External corporate entity	**2004**	**Span 2004**	**2013**	**Span 2013**
Pori Energy Ltd.	Yes	Local	Yes	Local, regional, national
KuntaPro Oy	Not available	Not available	Yes	Local, national
Porin Linjat Oy (bus company)	Not available	Not available	Yes	Local

Table 4.14 Contacts to external stakeholders: organisation, association, company and personal contacts of Pori Water in 2004 and in 2013.

Contact type	**Group or organisation**	**2004**	**Span 2004**	**2013**	**Span 2013**
Environmental association	Water Protection Association of the Kokemäenjoki River (KVVY)	Yes	Regional	Yes	Regional
Environmental authority	Southwest Finland Regional Environment Centre (merged to the Centre for Economic Development, Transport and the Environment (ELY Centre) in 2010)	Yes	Regional, national	Yes	Local, regional, national
Public authority	Register Office	Yes	Local, national	Not available	Not available
Emergency Response Centre	Police and rescue services	Not available	Not available	Yes	Local, regional
Customers	Industries and private customers	Yes	Local	Yes	Local, regional
Customers	Health care institutions (i.e. hospitals), private customers	Not available	Not available	Yes	Local, regional
Software companies and IT service providers	Tekla/Trimble Various software and service companies	Yes	National	Yes	National
Building automation companies	Building automation systems (including instrumentation and electric companies) Local teleoperators Locksmiths	Yes	Local, regional, national	Yes	Local, regional, national
Construction companies	Construction companies	Not available	Not available	Yes	Local, regional, national
Manufacturers	Equipment, pumps, valves, pipes, water meters, sewer cameras, etc. manufacturers	Yes	Local, regional national	Yes	Local, regional, national
Wholesalers	Various wholesalers	Yes	Local,	Yes	Local,

			regional, national		regional, national
Suppliers	Chemicals, reagents, detergents, etc.	Yes	Local, regional, national	Yes	Local, regional, national
Maintenance companies	Various maintenance companies	Yes	Local, regional, national	Yes	Local, regional, national
Contractors	Various contractors	Yes	Local, regional, national	Yes	Local, regional, national
Consultancy companies	Various consultancy companies	Yes	Local, regional, national	Yes	Local, regional, national
City of Rauma	Rauma Foodstuffs Laboratory	Yes	Regional	Not available	Not available
Colleagues	Colleagues at other water utilities	Yes	Regional, national	Yes	Regional, national
Colleagues	Colleagues from other professional disciplines	Yes	Local, regional, national	Yes	Local, regional, national
Colleagues	Management secretaries in the City of Pori	Yes	Local	Not available	Not available

From the results gathered in 2004 and in 2013 it can be concluded that work-related networks, especially external networks at Pori Water were large and quite stable and included multiple sectors. Internal networks were typically used to solve work-based practical problems with the closest co-workers and superiors. Personnel in the management positions dealt with, of course, wide-ranging organisational and development issues, which had impact on individual units or on the whole organisation. The external contacts with the City of Pori were administrative and used for regular communication on official matters. These networks were fairly static: the main change concerned financial administration services, which were transferred to the external corporate entity of the City of Pori. The composition of external network in 2013 showed some increase in the contacted organisations, associations, companies and people. Many interviewees mentioned the need to contact software companies for information and guidance. The interviews revealed fewer contacts to other water utilities in 2013 than in 2004. Earlier, other water utilities in Tampere, Turku, Vaasa and Rauma were visited annually. In 2013 regular professional visits to other water utilities had ceased, resulting in loss of information and experiential knowledge sharing among the closest water utilities. This development might be related to the hectic pace of work and the retirement boom. Long-term professional contacts may have disappeared when a substantial number of personnel retired, and close relationships may not have transferred from one generation to the next or the younger generation favoured other type of co-operation.

4.6 Utilisation of employees' skills and knowledge

Question 33 in the interview dealt with personnel's views on skills and knowledge utilisation. In 2004 58 percent and in 2013 70 percent of all interviewees thought that employees' skills and knowledge were utilised well or very well at Pori Water. To summarise the "'very well' and 'well' categories, in 2004 the highest rating of 70 percent and in 2013 75 percent was given by those who had worked less than 10 years at Pori Water. The lowest of 52 percent and 60 percent, respectively, were given by those having worked more than 30 years at Pori Water.

In 2004 altogether 28 percent of the interviewees indicated that skills and knowledge are utilised somewhat or little. Those with more than 10 years' working experience were more critical than those with less than 10 years' working experience. Fifteen percent of the interviewees did not want to give their opinion on this issue. The 'very little' and 'not at all' options were chosen by no-one. In 2013 altogether 15 percent of the interviewees indicated that the skills and knowledge are utilised 'some' or 'little', and nine percent chose 'very little' or 'not at all'. Those with more than 30 years' working experience were more critical than the others. The 'very little' and 'not at all' options were chosen only by those having worked more than 20 years at Pori Water. Six percent of the interviewees did not want to give their opinion on this issue.

In 2013 the personnel of Pori Water seemed to be more satisfied with their knowledge and skills utilisation than in 2004. During the same period the proportion of opinions of 'very little' or 'not at all' had increased from zero to nine percent. Figure 4.10 shows the perceived skills and knowledge utilisation in detail at Pori Water classified by the number of employees' working years.

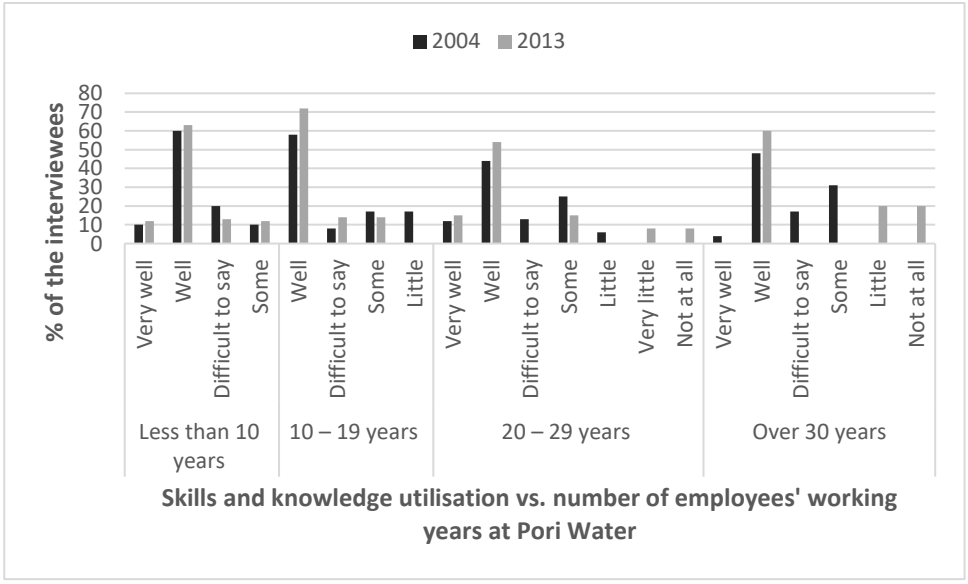

Figure 4.10 Skills and knowledge utilisation classified by the number of employees' working years at Pori Water in 2004 (n=61) and in 2013 (n=33).

If skills and knowledge utilisation is considered from the point of the various personnel groups, general changes in 2004 and in 2013 can be summarised as follows:

- *All personnel groups, except fitters and storekeepers, thought that their skills and knowledge were utilised as well as or better in 2013 than in 2004, when considering the categories, 'very well' or 'well'.*
- *In all personnel groups, except fitters and storekeepers, the 'difficult to say' category answers decreased to zero percent in 2013.*
- *'Some' category replies remained the same in the administrative staff's group (33%), plumbers and storekeepers remained the same (0%), secretaries, foremen, plant workers, other technical personnel and laboratory workers dropped to zero percent, operators decreased from 75 to 50 percent, planning officers increased from zero to 14 percent, and fitters increased from zero to 34 percent.*
- *The options of 'little' and 'very little' were not selected by anyone belonging to the categories of administrative staff, fitters, operators, plant workers, other technical personnel, laboratory workers and storekeepers, neither in 2004 nor in 2013. Foremen and plumbers answers decreased to zero, secretaries from 22 to 17 percent and planning officers increased from 14 to 17 percent from 2004 to 2013.*
- *Seventeen percent of secretaries and 25 percent of foremen indicated in 2013 that their skills and knowledge were not at all utilised. The change is notable because no one from these personnel groups responded with 'not at all' in 2004.*

4.7 Means of increasing knowledge

The question inquiring the personnel's thought about the ability of different means of increasing knowledge at Pori Water had several options, which were all assessed in interviews (question 19). Needs for new employees or skills was asked about in question 34. However, none of the respondents mentioned skills.

In 2004 about one-third (35%) of all responses indicated that engaging new, qualified personnel is a 'good' or 'very good' means to increase knowledge. Forty-one percent of the answers indicated some increase in knowledge from it. Fifteen percent said that it would have little or very little effect, and seven percent saw no effect at all. In 2013 30 percent of all responses indicated that engaging new, qualified personnel is a 'good' or 'very good' means to increase knowledge. Thirty-six percent of the answers indicated some increase in knowledge from it, 34 percent said that it would have little or very little effect, and three percent saw no effect at all. The proportion of 'some', 'well' and 'very well' options chosen decreased from seventy-six percent in 2004 to sixty-six percent in 2013. At the same time 'little' and 'very little' answers increased from 15 percent to 24 percent. These figures indicate that engaging new, qualified personnel had lost some of its effectiveness as a means to increase the knowledge at Pori Water. The current staff policy limits the possibilities to hire new personnel, which reflects in the answers to the question relating to means to increase knowledge.

Needs for new employees were listed similarly in 2004 and in 2013 in question 34. Half of the interviewees mentioned the need for foremen, plumbers, fitters, controllers and customer service personnel. Truck driver services were being outsourced already before 2004, but still in 2013 some employees saw need for them. In 2004 there was need of a PC advisor and a controller, and the utility hired an ICT specialist in 2005 and one of the secretaries attended training for financial managers in 2013. Some respondents said that services, like programming, automation, electrical engineering, etc. could be purchased from companies. The results show an open-minded attitude of new employees was qualification respondents valued the most. They also emphasised that time is needed for workplace orientation. This finding calls for sustainable human resources planning.

In 2004 commissioning services from consultants was not seen as a good method of increasing knowledge. Only 13 percent viewed it as 'good' or 'very good' for this purpose. Twenty-eight percent of the respondents thought that some increase in knowledge was possible through this method. Twenty-one percent said it has little or a very small effect, and 18 percent saw no effect at all. In 2013 almost half (48%) of the interviewees valued commissioning services either as not effective at all or gave a 'little' or 'very little' value to it as a mean of increasing knowledge. The proportion of 'little' and 'very little' answers was the same in the 2004 and the 2013 responses, but 'no effect' answers had increased from 18 percent to 27 percent by 2013. Twenty-one percent could not answer this question. One positive sign was seen in the increase in 'well' and 'very well' categories: from 13 percent in 2004 to 18 percent in 2013. Some belief in effect was gained by 21 percent in 2013 compared to 28 percent in 2004. Some interviewees said that services are not commissioned as much as they were earlier.

In 2004 thirty-three percent of all responses indicated that contacts with manufacturers and service providers were a 'good' or 'very good' means to increase knowledge. Thirty percent of the respondents thought that there was some increase in knowledge from these contacts. Seventeen percent thought they have little or very little effect, and 8 percent saw no effect at all. The results from the 2013 interviews indicate that manufacturers and service producers had kept the same position on this topic, that these contacts were good or very good (altogether 30%) means to increase knowledge. Thirty percent also answered 'some'. 'Little' or 'very little' was chosen by 15 percent of participants, which was a slightly smaller share than in 2004. One major change was in the category of 'no effect'; the number of these responses on this subject almost doubled (from 8% to 15%). The interviewees thought that manufacturers and service providers do not visit Pori Water as often as they had earlier.

Purchasing of equipment was believed by 33 percent of all respondents in 2004 to be a 'good' or 'very good' means of increasing knowledge, and by 36 percent in 2013. Some increase was seen to derive from it by 38 percent and 27 percent of the respondents, 10 percent and nine percent said that it has little or a very small effect, and 11 percent and 18 percent saw no effect at all. These figures show that the proportion of employees who do not see any knowledge increase due to purchasing equipment has risen. A similar trend can be seen in the 'some' category.

Participation in conferences, seminars, exhibitions and fairs was seen a very good means to increase knowledge in both interviews. In 2004 forty-nine percent of all responses said that participation in conferences, seminars, etc. was a ‘good’ or ‘very good’ means of increasing knowledge. Some increase was indicated by 31 percent of the answers, 12 percent said that the participation has little or very little effect, and only two percent saw no effect at all. In 2013 84 interviewees said that there is at least some effect; ‘good’ and ‘very good’ responses had risen up to 63 percent, and ‘some increase’ responses had gone down to 21 percent. ‘No effect’ was not mentioned at all, and ‘little’ or ‘very little’ only by two (6%) interviewees.

In 2004 28 percent of all responses indicated that publications and journals are a ‘good’ or ‘very good’ means to increase knowledge. Some increase from them was indicated by 51 percent of the respondents, five percent said that they have little or very little effect, and five percent saw no effect at all. Twenty-one percent of the interviewees in 2013 could not say if there was an effect on the increase of knowledge or not due to publications and journals. The overall trend found was that traditional, i.e. printed, publications and journals are still important sources of knowledge, but their relative importance had decreased. The outcome of combining the groups ‘good’, ‘very good’ and ‘some’ was that it showed that more than half (54%) of the interviewees considered the importance of publications and journals as high or quite high. Printed publications and journals did not have any effect on the knowledge increase, according to 15 percent of the responses in 2013, while in 2004 the figure was only five percent.

In 2004 computer programs and licences were considered ‘good’ or ‘very good’ means of increasing knowledge according to 26 percent of all respondents. Some increase from them was indicated by 38 percent of the participants. Eight percent said that they have little or very little effect, and eight percent saw no effect at all. In 2013 the responses were divided quite evenly between the different options. However, every fourth interviewee could not comment the role of computer programs and licences. ‘Good’ and ‘very good’ options were chosen by 18 percent, ‘some’ by 21 percent, and ‘little’ or ‘very little’ by 15 percent. Roughly every fifth respondent (21%) shared the opinion that computer programs or licences do not increase the knowledge. Some of the interviewees emphasised that computer programs and licences were considered equipment or media for storing and handling information.

In 2004 every fourth interviewee (25%) indicated that research and development work is a ‘good’ or ‘very good’ means to increase knowledge. Some increase from it was indicated in 44 percent of the answers. Eleven percent said that it has little effect, and three percent saw no effect at all. In 2013 ‘good’ and ‘very good’ evaluations were received by almost the same share of interviewees (24%) as in 2004. A substantial decrease was indicated in the category ‘some’, namely it dropped down to 18 percent. Research and development work gave little or very little increase to knowledge according to 27 percent of the responses, and no effect was seen by 15 percent. When the categories of ‘very good’, ‘good’, and ‘some’ are combined and compared against the combination of the categories of ‘little’, ‘very little’, and ‘no effect’, the combined categories represent 42 percent each. This may be

explained by the fact that the interviewees thought that research and development work had been commissioned less during the last years.

Personnel training was seen by 33 percent of all respondents in 2004 as a ‘good’ or ‘very good’ means of increasing knowledge, and by 48 percent in 2013. Some increase from it was indicated in 43 and 18 percent of the answers, respectively. In 2004 12 percent said that it has little or very little effect, and seven percent saw no effect at all, while in 2013 those categories each got nine percent of the responses. In 2013 personnel training had a great deal of influence on the employees of Pori Water, since almost half of the interviewees said that it increases knowledge well or very well.

In 2004 altogether 26 percent of all responses indicated that interviews and questionnaires addressed to customers were a ‘good’ or ‘very good’ means to increase knowledge. Some increase from them was indicated in 36 percent of the answers, 11 percent said that they have little or very little effect, and seven percent saw no effect at all. In the 2004 to 2013 time frame, customer interviews and questionnaires lost a little of their impact as means to increase knowledge. ‘Good’ and ‘very good’ was chosen by 24 percent, ‘some’ 21 percent, ‘little’ and ‘very little’ 18 percent, and ‘no effect’ 9 percent. Twenty-seven percent felt it difficult to evaluate their impact. Customer interviews or questionnaires were used seldom, which might explain their low ratings.

Benchmarking against other water utilities was seen as a very good means to increase knowledge. In 2004 all interviewees said that it increases knowledge at least a little: 65 percent said that it is a ‘good’ or ‘very good’ means for that, 25 percent saw some benefit from it, and 10 percent said that it has little or very little effect. Results from 2013 showed that the role of benchmarking had decreased; less than half of the interviewees (48%) felt that benchmarking increases knowledge well or very well, and some effect was perceived by 12 percent. From 2004 to 2013 the previous two categories together had fallen from 90 to 60 percent. There were no totally negative attitudes in 2004, but in 2013 nine percent of the interviewees said benchmarking had no effect at all.

Some interviewees in 2004 and 2013 mentioned other ways to increase knowledge, too. These ways included internal meetings, trainings, newspapers and broadcasts, electronic media, customers, connections to cities and municipalities, and networking. Internal meetings, either formal work group meetings or informal discussions with co-workers, were clearly the other main ways to spread and obtain knowledge. On-the-job training, further education, congresses, and fairs were the next favoured. The internet, customers and networking were also seen to increase knowledge at Pori Water.

Table 4.15 shows by personnel groups how ‘good’ or ‘very good’ different means were believed to be increasing knowledge and Table 4.16 summarises the means that different personnel groups rated as ‘very little’ or ‘not at all’. The cleaners group was left out, because no such personnel group existed in 2013.

Table 4.15 Good and very good means to increase knowledge at Pori Water in 2004 and in 2013 classified according to the means and different personnel categories. Percentages indicate the share of interviewees in each personnel category who evaluated means to be 'good' or 'very good'.

Means	**Year Change**	**Administrative staff**	**Planning off.**	**Secretaries**	**Foremen**	**Plumbers**	**Fitters**	**Operators**	**Plant workers**	**Other technical personnel**	**Laboratory workers**	**Storekeepers**
Engaging new, qualified staff	2004, %	100	71	11	60	34	33	0	0	25	100	0
	2013, %	100	17	17	50	0	0	0	100	0	100	0
	Change	–	↓	↑	↓	↓	↓	–	↑	↓	–	–
Ordering services from consultants	2004, %	33	14	11	0	0	0	50	0	25	33	0
	2013, %	0	33	17	50	0	0	25	0	0	0	0
	Change	↓	↑	↑	↑	–	–	↓	–	↓	↓	–
Contact with manufacturers and service providers	2004, %	33	29	22	20	50	0	25	14	38	33	100
	2013, %	0	50	17	75	50	33	0	0	0	0	100
	Change	↓	↑	↓	↑	–	↑	↓	↓	↓	↓	–
Equipment purchases	2004, %	33	14	44	60	17	33	25	29	38	33	33
	2013, %	33	33	17	75	100	0	0	0	100	50	100
	Change	–	↑	↓	↑	↑	↓	↓	↓	↑	↑	↑
Participation in conferences, etc.	2004, %	67	57	33	40	34	33	100	29	63	33	33
	2013, %	67	50	33	50	50	100	75	0	100	100	100
	Change	–	↓	–	↑	↑	↑	↓	↓	↑	↑	↑
Publications and journals	2004, %	33	29	22	40	0	0	75	14	26	0	33
	2013, %	100	17	0	75	0	0	25	0	0	0	0
	Change	↑	↓	↓	↑	–	–	↓	↓	↓	–	↓
Computer programs and licences	2004, %	0	50	56	60	0	0	50	0	26	33	0
	2013, %	0	14	0	25	0	0	50	0	0	0	100
	Change	–	↓	↓	↓	–	–	–	–	↓	↓	↑
Research and development	2004, %	33	29	22	40	0-	0	25	0	25	33	0
	2013, %	0	33	33	50	0	0	0	0	0	50	100
	Change	↓	↑	↑	↑	–	–	↓	–	↓	↑	↑
Staff training	2004, %	0	0	67	20	17	33	25	14	26	67	100
	2013, %	0	83	50	75	50	0	50	0	0	50	0
	Change	–	↑	↓	↑	↑	↓	↑	↓	↓	↓	↓
Customer interviews/ questionnaires	2004, %	0	0	67	20	33	0	0	29	25	33	0
	2013, %	9	33	50	50	50	0	0	0	0	0	0
	Change	↑	↑	↓	↑	↑	–	–	↓	↓	↓	–
Benchmarking against other water utilities	2004, %	0	43	22	60	33	100	75	71	51	100	0
	2013, %	67	33	17	75	100	33	50	100	0	100	0
	Change	↑	↓	↓	↑	↑	↓	↓	↑	↓	–	–

Table 4.16 Ineffective means to increase knowledge at Pori Water in 2004 and in 2013 classified according to the means and different personnel categories. Percentages indicate the share of interviewees in each personnel category who replied that means have 'very little' or 'no effect' at all.

Means	**Year Change**	**Administrative staff**	**Planning off.**	**Secretaries**	**Foremen**	**Plumbers**	**Fitters**	**Operators**	**Plant workers**	**Other technical personnel**	**Laboratory workers**	**Storekeepers**
Engaging new, qualified staff	2004, % 2013, % Change	0 0 –	0 17 ↑	0 0 –	0 25 ↑	34 0 ↓	0 0 –	50 0 ↓	14 0 ↓	25 0 ↓	0 0 –	0 0 –
Ordering services from consultants	2004, % 2013, % Change	0 0 –	14 17 ↑	22 50 ↑	40 50 ↑	40 100 ↑	67 67 –	25 25 –	14 100 ↑	51 100 ↑	0 50 ↑	0 0 –
Contact with manufacturers and service providers	2004, % 2013, % Change	0 0 –	0 0 –	22 33 ↑	0 0 –	0 0 –	67 0 ↓	50 100 ↑	29 0 ↓	0 100 ↑	33 0 ↓	0 0 –
Equipment purchases	2004, % 2013, % Change	0 0 –	0 17 ↑	0 33 ↑	0 25 ↑	0 0 –	0 67 ↑	0 25 ↑	14 100 ↑	25 0 ↓	33 0 ↓	0 0 –
Participation in conferences, etc.	2004, % 2013, % Change	33 0 ↓	0 0 –	0 0 –	0 0 –	34 0 ↓	0 0 –	0 0 –	0 0 –	13 0 ↓	0 0 –	0 0 –
Publications and journals	2004, % 2013, % Change	0 0 –	0 17 ↑	0 17 ↑	0 0 –	34 0 ↓	33 0 ↓	0 25 ↑	14 100 ↑	0 100 ↑	0 50 ↑	0 100 ↑
Computer programs and licences	2004, % 2013, % Change	0 0 –	14 17 ↑	0 17 ↑	0 25 ↑	50 50 –	33 33 –	0 25 ↑	0 100 ↑	0 0 –	0 100 ↑	0 0 –
Research and development	2004, % 2013, % Change	0 33 ↑	0 17 ↑	0 0 –	20 50 ↑	17 50 ↑	0 0 –	0 50 ↑	0 100 ↑	0 0 –	0 50 ↑	0 0 –
Staff training	2004, % 2013, % Change	0 0 –	0 0 –	0 0 –	20 25 ↑	34 50 ↑	33 33 –	25 0 ↓	0 100 ↑	38 0 ↓	0 0 –	0 0 –
Customer interviews/ questionnaires	2004, % 2013, % Change	0 0 –	14 17 ↑	0 0 –	20 25 ↑	0 50 ↑	0 0 –	25 50 ↑	0 0 –	13 0 ↓	0 50 ↑	33 0 ↓
Benchmarking against other water utilities	2004, % 2013, % Change	0 0 –	0 17 ↑	11 33 ↑	0 0 –	0 0 –	0 33 ↑	0 50 ↑	0 0 –	13 0 ↓	0 0 –	0 0 –

4.8 Knowledge sharing practices

Questions 13–16 and 32 concentrated on documented information and knowledge while question 28 raised up the tacit component of knowledge. The capturing of stories was the subject of questions 29−31.

4.8.1 Documented material sharing

In 2004 every fourth (16 answers, 26%) interviewee said that there is a library or organised collection of documents at Pori Water, 54 percent (33 answers) said that there is no library or collection, and 20 percent (12 answers) had no knowledge about the issue. Almost all of those who gave a 'no' answer said that they do not consider the small book collection in the meeting room at the Ulasoori unit to be a library. The interviewees further explained that many employees have a collection of manuals and brochures in their office. In 2013 14 (42%) of the interviewees said that there is a library or organised collection of documents at Pori Water, 14 (42%) said that there is no library or collection, and 5 (16%) had no knowledge about the issue. The existence of the small book collection at the Ulasoori unit was recalled only by a few. The interviewees further explained that they use the internet as a source of information. They explained that the most recent information, like manufacturers' catalogues, can be found online. Thus, there is no need to store manuals or brochures in their office.

In 2004 the question on information services availability indicated clearly that no such services exist: 69 percent (42 answers) said 'no', and 21 percent (13 answers) did not know anything about information services availability. According to 10 percent (six answers), information services exist: if needed, they get information from supervisors. In 2013 82 percent (27 answers) of the interviewees said that no information services are available. Two interviewees (six percent) said that these services exist, and four (12 percent) said that they do not know anything about these services. Those who answered 'yes' considered personal information requests from other staff members to be library services.

In 2004 the library, other document collections and information services of Pori Water were generally not used. Eighty-nine percent (54 of the interviewees) never used them while 11 percent (seven of the interviewees) used them a couple of times per year. The situation was almost the same in 2013, when 88 percent (29 persons) never used them, and 12 percent (four persons) used them a couple of times per year.

In 2004 more than half (54%, 33 answers) of the interviewees said that there is no need for an organised, physical library, 31 percent (19 answers) said that an organised library is needed, and 15 percent (9 answers) could not give their opinion on this topic. In 2013 'no need for organised library' opinions had increased to 61 percent (20 of the interviewees). Thirty-six percent (12 persons) thought there is need for an organised library, and six percent (three persons) could not comment on the issue. The interviewees wondered where such a library should be located to also benefit the units

at a distance from it. Moreover, they wanted to use online knowledge sources instead of the physical library.

In 2004 forty interviewees (80%) said that stories have not been recorded. Only three interviewees (5%) said that stories have been recorded while 15 percent (none answers) of the interviewees could not say. Based on the results in 2013 interviews the recording of stories had been actively done. Fifty-eight percent (19 interviewees) said that recall the story recording practice, 30 percent (10 of the interviewees) said that it has not happened, and remaining four persons (12 percent) could not say 'yes' or 'no'.

The ones who answered 'yes' interpreted recording to mean stories printed in the personnel newsletter and collected during the writing of *The 100 Years History of Pori Sewage Works*, which was completed in 1993. Stories were also collected in 2009, when the comprehensive 'History of Pori Water Services' was written. In 2004 most of the employees (64%, 39 answers) said that stories should be recorded, 20 percent (12 answers) were of the opinion that there is no need to record stories, and 16 percent (10 answers) did not have any opinion. In 2013 64 percent (21 interviewees) said that stories should be collected, 24 percent (8 interviewees) had the opinion of 'no need for collecting', and 12 percent (four interviewees) could not say. Collection of stories was supported equally in 2004 and 2013.

Pori Water annually commissions research and development projects. All projects are reported in electronic and/or written form. Usually the reports are placed on coffee tables for flipping through. In 2004 more than half of the personnel knew that reports had been published, and 25 percent knew that reports on some of the projects existed. Twenty percent could not say whether reports had been written or not. In 2013 more of the staff knew that research and project reports had been written. Seventy percent (23 persons) answered 'yes' to this question, and 15 percent (five persons) thought that some research and development reports existed. Fifteen percent (five persons) did not know about the issue.

In 2004 the general view was that the reports were accessible. Fifteen percent of the interviewees said that reports were not available while 25 percent could not give an opinion. Gender affected the answers in this case. Roughly half of the females said that reports were accessible while and the other half could not give an opinion. Of the males, 63 percent said they had access to reports while 21 percent said they had no access. In 2013 two-thirds (70%) shared the opinion that reports of the research and development work were accessible. Only one of the interviewees said that they were not available. Twenty-seven percent (nine interviewees) could not answer this question. In 2013 gender did not have effect on the opinions: 67 percent of males and females said they could access the reports, while 25 percent of the males and 33 percent of the females felt they did not have access to the reports.

4.8.2 Stories and storytelling

During the interviews the employees were not very eager to tell stories (questions 29−31). Most of them were too modest, claiming that they are not storytellers. In 2013 most of the interviewees said that stories are not told to the extent that they used to be in the earlier days. Storytellers, the greybeards, had for the most part retired. Of course employees could recall past memories, but times had changed, the work load was straining, and possibilities for new story spreading had decreased. In older times the staff members actively took part in free time activities together, too. In 2013 the leisure-time interests were different, and the community spirit was being maintained in other social groups outside of the water utility personnel.

However, a total of 35 stories were recorded in 2004, and three in 2013. The stories mainly dealt with the following:

(i) work procedures (13 stories) describing former working methods and equipment and their special properties

(ii) events at Pori Water (two stories) like the opening of the water utility and official public presentation of future plans

(iii) former and present employees (13 stories) concerning charismatic workers, blunders committed by employees, etc.

(iv) customer relations (six stories) involving complaints, attitudes, and problems customers had created

(v) rumours (one story) without substance, like when the fixing up of the premises was interpreted to mean privatisation

(vi) miscellaneous (three stories), like breaking into water work's premises or loosing items (wedding rings, false teeth, etc.).

The role of stories was seen as two-fold: some thought that stories were only meant to be amusing, while others viewed them as educational. Stories contain knowledge, either tacit or explicit, and they also reflect attitudes as the following example concerning pipe laying reveals:

> *One of the plumbers told that he has to assess excavator contractors continually. If the contractor is familiar to him and he knows that the contractor is reliable and knows the business, he can leave the contractor alone on the site and go pick up needed pipes, supplies, etc. With an unfamiliar contractor he is cautious and cannot leave him alone. He has to remain on site to assure that no electric cables are damaged. If the plumber leaves the site to fetch supplies, the excavator contractor has to stop working until the plumber returns.*

The story heard from a former employee was told a couple of times during the interviews in 2004. The same story is also included in *The 100 Year History of Pori Sewage Works* (Kuula 1993, 38).

The story dating back to 1950 tells about construction supervisor Rautanen who wrote poetry. At the time the unemployment rate was high and some relief work was organised. One Saturday a cofferdam collapsed at a pier construction site where the workers were drunk. When the site supervisor, Mr Hänninen, noticed what had happened, he phoned the warehouse in Varvi. Mr Rautanen answered and wrote down the report concerning the incident in the humorous style typical of him (in Finnish):

Pato rikki –sakki känninen
paha tikki – soitti Hänninen
Free translation:
Dam broken – Men loaded
Tough luck − Hänninen noted

The following happened with one of the customers.

A water mains pipe was laid in the area where a female customer lived. The water was turbid and brown. One of the plumbing foremen gave the lady permission to run water. He said to the lady: 'You can run 5000 litres of water, which is equal to 5 cubic metres; that much you can run'. He added that, 'when you come home from work, you should start immediately running the water so the brownish colour will disappear'. When the lady got her water bill, she was astounded. She called Pori Water billing and said the she was promised to run 5000 cubic metres of water. Every day when she had returned home from work, she had turned on the tap, letting the water run for the whole evening. The bill was enormous because during the summer time she had managed to run 800 cubic metres of water. The lady was really surprised when the clerk tried to explain that 5000 litres equals five cubic metres. 'You must have mixed up litres and cubic metres', said the clerk. The lady answered: 'I have taken advanced level mathematics, but I cannot understand this'. The customer was compensated for the misunderstanding.

One Saturday a technician was on call. At 11.30 p.m. a fellow, who was a little drunk, phoned.

Come quickly and change the water meter', said the man on the phone, and continued 'it is leaking'. The technician asked: 'Can you close the valve, so that the water meter does not leak anymore?. The man on the phone replied: 'Yes, I can, but then the family will have no water'. The technician explained: 'if we come right now to change the meter, it will cost a lot, I should say about 2000 Finnish Marks'. 'It does not matter how much it costs, just come and change it.', said the man. The technician was curious to know why the meter had started to leak. The man explained that he was supposed to go hunting with friends, but unfortunately the trip was not realised. He had been sitting in a chair taking aim with his gun. As he aimed at the water meter, the gun went off and the bullet pierced the meter. At this stage the technician said: 'Listen now, we are not going to come change the meter, you just close the valve'. 'Come now, I have plenty of liquor', begged the man, and continued

'when you come there will be drinks for you and the boys'. The technician replied: 'Not this time, thanks'. The man continued by saying: 'At least send the boys'. 'I am not going to send anyone', said the technician and continued 'You are now going to sleep through the night. Call me Sunday morning if you still want the meter changed. We will come on Sunday and change the meter'. Sunday morning at 10 o'clock the man phoned and excused himself by saying: 'The things you do when drunk!

During the phone call on Saturday, the technician had wondered whether he should call the police. The man was wielding his gun in a house where he believed other family members to be present. Finally, the technician decided not to call the police, but his sleep was quite troubled. Later on, he heard from a fellow who knew the man that the family had left the man a long time ago.

In the City of Pori all water meters are sealed, and the customers are not allowed to change them by themselves. In other places, like Ulvila, Pomarkku and Kankaanpää the water meter is given to the customers who can install it. The following episode occurred in the summer of 2003.

One day a woman came to the customer services section and placed a plastic bag on the desk. The junior clerk looked into the bag, and noted to the woman: 'Oh dear, you have uninstalled the meter'. The woman pleaded: 'No, not me, but my husband'. The couple had recently moved to Pori from Pomarkku, so they were not aware of the local practice. They had uninstalled the meter, and the husband has asked the woman to pick up a new one. 'Have you also closed the street valve', questioned the junior clerk. Yes, they had. The junior clerk was about to open her mouth and continue the hearing. The other clerk looked the junior clerk straight in the face. The junior understood that she should not ask anything else. She picked up the bag with the meter, and showed the woman to the meter section. 'This woman has uninstalled her water meter. Will you take it from here, please', said the junior clerk to the meter mechanics. Then she returned to her desk and burst into laughter, no longer able to contain herself after seeing the disbelief on the faces of the mechanics who could only respond: 'Oh indeed?

The next episode is from the time when the wastewater works was merged with the water utility.

One morning a foreman told one fellow to work as the driver's mate on the sewage lorry. During the coffee break, the lorry came into the garage. Only the driver was sitting in the cabin. The foreman saw the other fellow and asked him, surprised: 'Why are you not in that lorry?' The fellow said: 'I work for the water utility, and I am not going to get in the wastewater works' lorry!'. It made a fine mess of things. Finally, the negotiating skills of the head of the utility were needed to solve the case.

The previous story aptly highlights the phenomenon described by Cohen and Prusak (2001, 14−15): social capital can also form clans and isolate groups, which can make their members narrow-minded and suspicious.

The miscellaneous stories deal with intoxicated individuals and illegal boating on a lake at Harjakangas water plant, breaking into water utility premises, and lost items in sewers. One tragic incident caused many worries.

> *The story is from the time when the new wastewater treatment plant was under construction. An aged woman left her home in the Toejoki district and intended to go to the Pori market square. Even though the way is straight, she lost her way, and vanished without a trace. The construction men came to work next morning, and found the woman sleeping in the flotation basin. Still today there is no explanation to how the aged woman had managed to get into the plant area. Every gate was locked, and the fenced without gaps. How she managed to get inside is still a mystery. She couldn't explain that either.*

The characteristics of the stories collected during the interviews deal with work procedures, events, former and present employees, customer relations and rumours. These characteristics seem to be consistent with the characteristics given by Cohen and Prusak (2001, 114−125) and Cowan (2014). Stories include key persons and their characters, events, challenges faced, successful cases, unsuccessful cases, and cases where wisdom was needed. Storytelling is a powerful way to transfer organisational knowledge and explain how things are done in the organisation. However, the findings of this research indicate that the role of stories in knowledge sharing has decreased.

4.8.3 Knowledge and tacit knowledge sharing practices

Considering all of the interviews carried out in 2004 and in 2013, it is apparent that knowledge and tacit knowledge was being shared mainly through daily tasks. The personnel highly valued professional skills and knowledge of the employees with a long working history at Pori Water. It was found that knowledge and tacit knowledge sharing happened at the actual work site where problems arose. Work procedures were demonstrated step by step, if necessary. There was no way to learn tasks and tricks from books or in the office. When help was needed, employees most often turned to their closest co-workers.

Knowledge, tacit knowledge especially, was shared automatically during every-day work. As one of the employees said in 2004, it is a question of transferring a tradition. It seems that there were established practices when it came to how tasks were performed. The documentation of, for example, pipeline repairs also followed a fixed format. For outsourced jobs, like earth works, Pori Water used two well-known and experienced contractors with whom they had long-term co-operation. The interviewees in 2013 repeated the same messages, but also challenged the then-current work procedures. It is crucial for employees to understand how past events and practices have shaped current situations, but work procedures should be developed further.

The role of more experienced co-workers was emphasised in the answers in both interviews. Knowledge sharing happened between newcomers and those with a long working history. Sharing also took place between co-workers. Some of them had been working with the same team, person or

persons for more than ten years, some even 20 years. Knowledge is shared, for example, during shift changes, as when operators tell about the state of the process or, after the weekend, the customer service desk gets information about burst pipes or other problems encountered. In 2004 some interviewees had contact with the utility through their parents or relatives who had previously worked there. One new aspect of the role of co-workers was identified in the 2013 interviews. If a successor for a retiring employee is chosen from the utility, the retiree will transfer the valuable knowledge to the new position holder. Sometimes, a person hired outside the utility or via municipal merges may transfer useful information to the new employee, for example, information of networks, pipe materials, valves, fittings, etc. As one of the interviewees said, knowledge is shared in teams and by working together, otherwise it is not possible to learn more sophisticated work methods or special tricks, for example, when working with 50 years old undocumented pipes.

The master-apprentice system was mentioned in several answers both in 2004 and in 2013. It is a training method where the experienced worker guides and mentors the newcomer. A few of the 2004 employees had attended formal apprenticeship training and found it to be beneficial. Formal apprenticeship training was not brought up in 2013.

It seems that in 2004 knowledge was shared in personal discussions and during breaks. Coffee table discussions provided employees with the news of what was happening in the utility. Although, as one of the interviewees assessed, 90 percent of the informal discussions had nothing to do with the work, the remaining 10 percent may have been valuable. Interestingly, the 2013 interviewees indicated that coffee table discussions had partly lost their relevance for knowledge sharing. In general, formal team meetings, monthly meetings, group meetings and talks prior to shift changes were valued higher in 2013 than in 2004. The formal team and other group meetings shared official information on the board's decisions, administrative issues, and future plans. Data and information stored on computers were not valued much in 2004 because the personnel preferred to hear things in face-to-face discussions. In 2013 computers were seen an additional way to acquire information, but as one of the interviewees stated, some of the information, for example customer details, cannot be publicly available. That type of information should be communicated face-to-face.

In 2004 knowledge management software was either seen as a helpful tool for storing data and information or as technical nonsense. At that time, use of the Tekla Xpipe water and wastewater network information system design application was said to be in its initial stage. It was seen to have possibilities in network management and maintenance operations. One of the interviewees stated that the Tekla Xpipe water and wastewater network information system design application software could be a great tool in delivering network information to future generations. In 2004 network leakages were repaired without leaving any documentation on how and where it was repaired. The Tekla Xpipe water and wastewater network information system design application makes it possible to document the network's condition and determine the networks' renovations needs. The name of the system had changed from its original name, and in 2013 it was called Trimble NIS, pipeline

design application. The system has proven to be a very useful tool: one of the interviewees noted that it serves well the purpose of storing and transferring knowledge across generations.

On the one hand, the personnel were fully aware of the importance of undocumented data, information, and knowledge. On the other hand, they were not certain about what information and knowledge is valuable enough to be documented. In 2013 respondents emphasised that not all information and knowledge is worth documenting. Also, the type of documentation troubled a few interviewees: for some reason video recording was not supported.

Attitudes and organisational issues were not the subject of the interview, but the interviewees raised them up anyway when questioned about tacit knowledge. Both in 2004 and in 2013 the results lead to the understanding that some of the personnel felt they were not receiving the information they had been expecting to receive. Some were possessive of the knowledge and showed great reluctance to share it. Personnel indicated a desire for dialogue and a context-specific and free work atmosphere instead of simply performing the work. Personal chemistry between co-workers, and employees' attitudes towards people and their tasks affected the sharing of tacit knowledge. Supervisors have great responsibility in creating a knowledge sharing atmosphere. They should encourage other employees to express their opinions and make suggestions in a free atmosphere. A couple of interviewees in 2013 were convinced of a better sharing atmosphere created by the young newcomers. However, quite many said that information and knowledge does not flow even though the problem has been admitted.

In both interviews many of the interviewees tackled the question of the generation gap between younger and older employees, where the older workers do not necessarily understand the younger ones and vice versa. The inability of older employees to absorb new knowledge quickly enough may irritate the younger ones, while the know-it-all attitude of the young irritates the old. Teams were found to be so stuck to their working procedures that, instead of integrating younger members into existing teams, they tended to direct younger workers to other tasks. Some of this behaviour was explained by older employees as a reluctance to guide the younger ones. On the other hand, the younger people should be able to discuss and treat older workers in a certain way. They have to know 'how to fish for knowledge' from them. These findings may be related to the fact that Dalkir (2011) noted in experts and novices working together: skilled and experienced experts have difficulties in articulating their know-how, while novices can more easily tell what they do because they follow manuals or how-to processes. Water utilities do not attract young people, and at the same time water utilities have limited resources to hire new employees, for example as summer trainees. Also, decision makers should start to pay more attention to the ageing populations and its implications.

In 2004 tacit knowledge was seen as shared as well as concealed. Some said that they actively shared any information and knowledge they had. Others emphasised that sharing depends partly on the receiver: the receiving person has to be active and be brave enough to ask questions. Some

were not willing to share knowledge at all. The situation remained the same regarding knowledge and tacit knowledge sharing in 2013. Tacit knowledge was associated, for example, with the following:

- *noises that pumps make: an experienced employee can tell from the noise whether a pump is working properly or what the problem with it is*
- *noises from structures: an experienced employee can tell from the noise if there is a problem or what kind of possible problem exists*
- *smell of the wastewater process: a certain type of a smell indicates process failure*
- *colour and structure of activated sludge indicates how the process works*
- *colour of the foam indicates pH value*
- *valves and their location in buildings: several valves have special features known only to those working in the area*
- *network information: all data is not available on maps, so information should be drawn from employees or through site observation.*

Difficulties in sharing tacit knowledge were revealed indirectly by the interviewees both in 2004 and in 2013. Personnel, from top to bottom, were concerned about the ageing of personnel and knowledge disappearing with them the day they retire or otherwise leave the utility. Few new employment contracts had been formed. This was one of the main reasons why tacit knowledge sharing was insufficient: there was no one available to receive transferred knowledge.

The results of the interviews in 2004 and 2013 indicate several reasons why sharing of knowledge is difficult. These can be summarised as follows:

- *high retirement rate, distorted age structure, mean age close to 50 years;*
- *no new personnel, no one to share knowledge with;*
- *no master-apprentice system;*
- *management and organisational structure does not favour sharing;*
- *exceptional cases or problems – for instance, manual operation of processes or special situations with processes occur seldom and are always case sensitive, meaning that exact knowledge cannot be documented;*
- *lack of time due to work burden;*
- *network maps partly out of date, older employees have knowledge which is not documented or shared;*
- *negative attitude towards sharing, unwillingness to share, employees prefer to keep knowledge as their private property;*

- *internal information flow incomplete, supervisors do not get information, for example, of problems occurring with equipment;*
- *gap between older and younger generations – do not speak the same language;*
- *personal characteristics and inactivity, people do not seek knowledge actively.*

4.9 Workplace orientation

As a new means of knowledge transfer the workplace orientation practices and interviewees' experiences on orientation were evaluated in 2013 (question 35) among the seven staff members who had been employed after the year 2004. They were employed in 2005, 2006, 2011 (two persons), 2012 (two persons) and 2013. Two of them had a vocational background, four had a bachelor's degree, and one a master's degree. Except for one who had only recently graduated, they all had previous work experience from seven to 36 years. The gender distribution was two females and five males. Almost all interviewees were satisfied with their workplace orientation.

During workplace orientation knowledge sharing and transfer occurred in many ways. Based on the answers, the following categories were formed:

(i) content and materials

(ii) learning-by-doing

(iii) previous experience

(iv) orientation network

(v) changing situations

(vi) miscellaneous.

The content of the workplace orientation varied from person to person, and depended on the tasks. The rules and regulations of Pori Water and the City of Pori were important in regards to content. Naturally, the information regarding accomplishment of work, safety at work, and current and timely duties were included in the workplace orientation. One of the interviewees criticised the superficiality of the workplace instruction. Every new employee should get the workplace orientation instructions and the check-list. However, two interviewees revealed that they had not received the instructions. Two answers showed that tours of all three units of Pori Water were not customary practices.

The workplace orientation instructions at Pori Water were devised both in printed and electronic form. In 2013 workplace instructions had the same format and content as in 2004. The printed instructions were given to a new employee upon arrival. A newcomer and the foreman were supposed to go through the instructions together. The instructions gave the newcomer a general

overview of the organisation of the City of Pori and the position of Pori Water in it. The instructions contained information about the duties of Pori Water as well all the activities of the water and wastewater network unit and treatment unit. Employment-related matters like employment contracts, payment of wages, working hours, breaks and their timing during the working day, holidays, absences and recording of working hours were explained in detail. The canteens, occupational health services, and leisure activities were also shortly mentioned. It was advised that further instructions on health and safety issues could be found in special folders at workplaces and on computers. The guidelines and rules contained information about internal information distribution channels (notice boards, shared computer drive, personnel newsletter *Vesiposti*, the intranet and the newsletter *Karhunpalvelus* of the City of Pori, telephone, e-mail and internet usage, the access control system, and transport equipment (Porin Vesi 2003, 1−15; Porin Vesi 2014, 1−15).

Learning-by-doing was crystallised by one of the interviewees as follows:

- *You have a million things to learn and do. Contents simply need to be grouped into small manageable units.*

New tasks were learned in daily work with the support from co-workers. The active role of the newcomer was reflected in their own learning process, and they coped with new tasks by acquiring additional theoretical background information voluntarily.

A self-evident fact was that the work experience from other water utilities facilitated the understanding of Pori Water. Work experience from other fields facilitated adaptation to a new working environment with dissimilar rules and regulations. Theoretical and practical knowledge gathered in degree education and training courses provided a good foundation to carry out work tasks.

During the work orientation period only the closest co-workers became familiar. Personnel in other units became acquainted with each other in their daily work or in in-house trainings or gatherings. Usually, the key person during the work orientation period was the immediate superior, and in some cases the current position holder. Two of the interviewees mentioned that they had previous personal contacts to staff members, whom they could consult if necessary.

Situations may change suddenly, and may influence the workforce and realisation of workplace orientation. Interviewees gave two examples. In one case, the construction of the treatment facility was in a hectic phase using up all manpower resources for weeks. Thus, there was no time for concentrating on the workplace orientation. In the other case, a newcomer's workplace orientation was interrupted at the beginning because of the supervisors' early maternity leave. After that, co-workers and other supervisors helped the newcomer when needed. In these cases, the newcomers were active themselves, and acquired the needed information from other workers, from workplace orientation instructions or from the internet. Both cases indicate that the workplace orientation process should be carefully planned before the new personnel start their assignment.

The major topic in the ‘miscellaneous’ category was summer trainees. The majority of the interviewees had guided summer trainees, and had arranged the workplace training for them. One of the interviewees thought that summer trainees had had better workplace orientation compared to the permanent job holders. As stated by one person interviewed, there was a dilemma ‘when trainee manages the job, he leaves’. The summer season and trainees were found to be a tough combination, because of personnel’s summer holidays. Simply, there was a lack of time for workplace orientation activities, and trainees got their orientation on-the-job.

The duration of the workplace orientation varied from person to person, and from task to task. Some interviewees had had chance to work for a period of time with a person planning to leave. Simultaneous work times varied from zero days to six months. The interviewees suggested that simultaneous work should last from two to eight weeks.

5 RESULTS OF TACIT AND CRITICAL KNOWLEDGE ISSUES IN WATER SECTOR CASES

This chapter provides results of the tacit and critical knowledge issues collected during the Water Services and Leadership Development Continuing Education Programme (WASLED, VETO-Vesihuollon johtaminen ja kehittäminen) in 2010 and in 2011. The research setting was explained in Sub-chapter 2.4. The WASLED programme aimed to help water sector actors to understand the scope of the water sector, and to develop leadership skills within the sector. During the 10-month course, participants gained the capacity to understand interactions between water and the society, leadership and management in water services, financial and business planning, asset management, emergency situations, customer service and corporate image management. Tacit and critical knowledge at water utility was one small part of the training programme. Twenty-two participants from various water authorities, organisations, associations and water utilities attended the tacit knowledge session in 2010 and 15 participants in 2011 at the Centre for Professional Development Edutech at Tampere University of Technology.

5.1 Tacit and critical knowledge in the water sector

5.1.1 Tacit knowledge in the water sector

According to the respondents from the water utilities and water organisations tacit knowledge refers to the following:

(i) network

(ii) a water utility as a whole

(iii) treatment processes

(iv) collection of water samples

(v) operation and maintenance practices

(vi) history of organisation and water utility

(vii) miscellaneous.

What stands out from these tacit knowledge categories is the network, which seems to be the most vulnerable part of the whole water supply and sewerage utility. Network maps might not be updated, and in particularly old, undocumented or insufficiently documented water distribution and sewer lines, there may be tacit knowledge, which only plumbers, fitters or already retired persons possess.

Locations of pipelines, pipe sizes and materials, construction dates, pipeline repair records, conditions of networks and risky pipelines, locations and accessibility of valves, operational and maintenance information of pumping stations and locations of water meters in buildings were revealed to be the most significant sources of tacit knowledge. Tacit knowledge in all previously listed types was also regarded as critical knowledge of well performing water utilities.

Tacit knowledge in the whole water utility system includes the operation of various utility processes and extraordinary situations. The risky units of utilities, weak or easily damaged or special maintenance-demanding pipes or equipment, equipment suitable for current utility applications and operations, and weekly and monthly maintenance routines all involve tacit knowledge.

In the treatment processes, tacit knowledge was found to be embedded in operational practices, control of treatment processes, and loading conditions. Maintenance of processes, pumping stations, equipment and systems together with extraordinary situations were linked to tacit knowledge. Tacit knowledge was also connected to technical applications, depending on the availability of documentation. Answers regarding tacit knowledge in the treatment processes highlighted extraordinary situations and means to resolve them. Performance of processes with differing operation procedures and, for example, the impact of seasonal variations on used operation procedures was understood to require tacit knowledge.

Tacit knowledge in collection of water samples was linked to collection sites and sound collection methods and procedures. Knowledge of the characteristics of water sites is an important factor of execution of sampling. Sampling is tightly linked to the knowledge of data systems and data networks.

Operation and maintenance practices contain a significant amount of tacit knowledge of local know-how, personal and company networks (contacts for further information), customers and their needs, best practices (including best working methods and old, no longer used working methods), forthcoming events or anticipation of implications, social skills of personnel at organisations and water utilities, work ethics at organisations and water utilities and prevailing practices.

Data and information regarding the history of organisations and water utilities may contain statistical data, which has not been reviewed, information of changes in operation or an organisation, information of construction projects, constructors, other projects and research work. These are potential sources of tacit knowledge.

The miscellaneous category included tacit knowledge connected to smells, visual perceptions and senses of touch, which are hard to articulate or illustrate. However, this category can be linked to all other categories.

5.1.2 Critical knowledge vs. tacit knowledge

Respondents defined critical knowledge to be knowledge crucial for operating water utilities successfully and that assures reliable water supply and sewerage services to customers. In water supply and sewerage systems, critical knowledge is at the same time vulnerable and crucial to the success of water utilities.

Examples of critical knowledge were:

- *Local knowledge, which is gathered over a long period of time, like 'it always happens this way in rainy springs'.*
- *Knowledge of old materials or work methods and the ability to combine knowledge on e.g. pipes installed in the 1970s.*
- *Knowledge of customers and stakeholders, their habits and backgrounds.*
- *At water utilities embedded in organisation culture, structures and processes.*
- *Lost or temporarily lost agreements, like tenancy agreements and easements.*
- *Undocumented or incomplete network maps. Missing information, e.g. about private underwater cables, verbal agreements, several connections in the same real estate, etc.*
- *Archives.*

Critical knowledge may contain details, but knowledge of a water utility should be seen as a unit. The amount of critical knowledge is huge and sometimes it is lost or converted to tacit knowledge. In large water utilities documentation and storage practices can lead to an information overload, and this might result in situations where employees do not know where to look for information or question if the accessed information is indeed the answer to what they are seeking. The other perspective on documentation dealt with use of knowledge: in extraordinary situations employees do not need additional information because they already possess the critical knowledge needed to solve the cases.

A common view amongst respondents was that the share of critical tacit knowledge depends on the amount of explicit knowledge. The share of knowledge that is tacit knowledge might vary between 20 and 30 percent in large organisations or water utilities. At small water utilities, the existence of tacit knowledge is significant because documentation practices are sometimes missing totally. Tacit knowledge is associated with context-specific task areas. Each water utility has special characteristics, which influence tacit knowledge. Respondents shared the view that critical knowledge transfers to tacit knowledge when the only person knowing a piece of information leaves the employer. One respondent group emphasised the role younger employees have on new working methods and systems.

5.1.3 Possession of tacit knowledge

Tacit knowledge is possessed by all employees of water utilities and organisations. The respondents emphasised the value of tacit knowledge gathered by experienced employees with a long work history, those employees retiring within next three to five years and those already retired. The importance of tacit knowledge was seen as essential and that it should be captured and shared instantly. Of the personnel groups, respondents emphasised surveyors, network inspectors, plumbers and fitters, plumbing foremen, plant workers, planning officers, water supply and sewerage engineers, managing directors and secretaries.

Respondents also stressed the role of stakeholders in the capture of tacit knowledge. Local contractors, sales representatives, suppliers of goods and equipment, water protection agencies, and other interest groups all possess tacit knowledge related to the organisation or water utility.

Accumulation of tacit knowledge varies from person to person. For every employee, information and knowledge gathering starts immediately when starting work. Respondents considered when one should be told about tacit knowledge, because they shared the vision that every employee has a variable amount of tacit knowledge, which gathers and changes over time. Respondents had noticed that traditional work practices and allocating tasks constantly to the same employees hinders development. It is fundamental to encourage and foster the sharing of tacit knowledge in collaborative working. On the other hand, this is a real challenge for organisations and water utilities.

5.2 Capturing and sharing tacit and critical knowledge

5.2.1 Capturing tacit knowledge

In 2011 the question on means and tools in use to capture tacit knowledge was added to the list of questions. According to the participants there are a number of means which could be used to elicit tacit knowledge. Job rotation, apprenticeships, smart questioning and documentation, and education and training, especially vocational qualifications in water supply services were reported. The means and tools were categorised as follows:

(i) documentation

(ii) quality and operation systems and audits

(iii) meetings and informal discussions

(iv) master-apprenticeship systems

(v) projects

(vi) workforce planning

(vii) miscellaneous.

Respondents prioritised documentation − quality and operation systems and audits − the core means and tools used at water utilities to share knowledge. Nowadays, water utilities are required to document practices and guidelines, using for example chemical safety data sheets, which may be included in a broader operation system. Netwk maps and maintenance records are already documented in electronic databases. Quality systems and audits will become more common at water utilities for evaluating and improving management. At water utilities, documentation and archiving should be seen as essential and continuous activities.

Conducting knowledge audits is one tool that can determine tacit and critical knowledge. The personnel's own tacit knowledge can be captured by self-evaluation, by identifying critical competencies and skills and by anticipating staff changes like retirements. Capturing tacit knowledge should be a critical and ongoing action at water utilities. Notice has to be taken to not transfer poor work procedures.

Official meetings, internal consultations, e.g. in projects or work practices, are means to share knowledge in general and particularly tacit knowledge. Coffee table discussions were means related to unofficial contexts. Raising smart questions and searching for information are good means to filling in knowledge gaps. Utilising master-junior apprenticeship clears the way for two-way knowledge and tacit knowledge sharing.

Projects were evaluated to share elements with workforce planning at water utilities. Respondents evaluated projects from two viewpoints. First, for younger employees, projects were seen as possibilities to independently search for information. Second, when employees were nominated for major projects, they were being entrusted to take responsibility and exemplify project management skills.

The issue of workforce planning was partly discussed in the previous paragraph. Other suggestions included working in pairs and offering employees other tasks. In good time before a retirement, a younger employee could be shifted to be a co-worker to the person intended to go on pension. Before the retirement, experienced employees could also benefit the water utility in other job positions, like working in quality control tasks.

Time, competences and skills were grouped into the miscellaneous category. All respondents agreed that knowledge sharing does not happen without time reserved for sharing possibilities and activities. Long-term experiences and perceptions reflected competences and skills needed to perform daily tasks, how the work tasks have been performed and how they should be performed.

5.2.2 Tools for capturing critical knowledge

A number of tools for capturing critical knowledge were mentioned. Four groups in 2010 and one in 2011 reported risk analysis and anticipatory risk management. However, before using any tools, the

critical factors have to be known. Participants emphasised that critical knowledge is interrelated with special situations, crises or problems. Special cases have to be analysed and documented in detail. Learning from mistakes, i.e. what has happened, what repair actions were taken, what went wrong and why, and what can be learned from the case, should also be documented. Special cases are a good source for new knowledge.

Long-term data collection and statistical applications are required for critical knowledge management. Critical knowledge can be captured in strategy processes. At water utilities total quality management systems and operating instructions serve as document storage for critical knowledge. Updating and upgrading the quality systems is important, and also, the less frequently used work procedures and videos on working processes should be included in the systems.

Human resources policies, processes and practices form effective knowledge retention tools at water utilities. Task descriptions with critical knowledge for all staff positions should be added to human resources systems. This includes identification of capabilities and key personnel with critical knowledge, succession planning and career development. Questions on critical knowledge should be included in development discussions, in team development discussions and in various feed-back discussions, i.e. after holiday shifts or special cases.

Other means to reveal critical knowledge included observing of employees or teams in action, operations-based exercises and training for emergency preparedness, benchmarking other water utilities processes, performance metrics, learning from best practices and workplace health promotion activities. Informal discussions during coffee breaks, sauna evenings and in other free-time activities can reveal critical knowledge.

In Finland ‘state and municipal authorities have the statutory duty to undertake measures, such as preparedness plans, to guarantee the continuity of their critical operations amid disruptions and emergencies’ (National Emergency Supply Agency (NESA, Huoltovarmuuskeskus in Finnish), 2016a). ‘In the event of disruptions and emergencies, the continuity-management methodology employed by organisations ensures the availability of core services to citizens, companies, and organisations’ (National Emergency Supply Agency (NESA), 2016b). With the continuity management tool, called HUOVI Analysis (huoltovarmuusanalyysi in Finnish), water utilities are able to do maturity analysis, analyse their own water utility’s operational continuity level, manage operational disruptions and ensure the availability of core services to citizens and customers. Water utilities can utilise HUOVI Analysis to identify critical weaknesses in operations and processes and perceive threats.

5.2.3 Sharing critical knowledge

Critical knowledge transfer was partly discussed already in the previous sections. Participants shared the same view on sharing critical knowledge: directly contact those who have the knowledge.

Generally, external and internal training support transfer of knowledge and internal training play an important part in sharing tacit knowledge.

During the 2010 WASLED programme the participants discussed at length the importance of documentation in sharing critical knowledge. Documentation systems should be created from scratch or existing ones updated to respond the operational needs of the water utility. Documentation should be a valuable knowledge retention practice enabling open access for personnel. Important data, information and knowledge should be available, including photographic images, digital images and video recordings. Documentation at water works is developed case by case, yet careful consideration is needed when evaluating documents to be stored in documentation systems. In this connection participants raised the question of what is the tacit knowledge which should be captured.

Good ways to share knowledge include internal discussion and information sessions, in-company meetings and team meetings, because the content of a message can be conveyed simultaneously to a large number of employees. Both in 2010 and in 2011 the participants emphasised the role of job rotation, exchange of knowledge between departments or units, projects, and master-apprenticeship in knowledge retention.

By working on water works projects, younger employees become integrated into the water utility's culture and practices and absorb valuable inside knowledge. Considering master-apprenticeship it should be remembered that the master could also be in a new position, as a teacher, and might need some assistance with effective teaching methods.

Team or group development discussions could substitute for individual development discussions at water utilities. Challenges related to the sharing of critical and tacit knowledge and attitude problems in sharing are up in development discussions. Exit interviews or inquiries for retiring persons or persons quitting should be included in the human development systems.

Participants said that water utilities should promote internal career development paths to keep critical and tacit knowledge in the organisation. They shared the opinion that anticipatory measures have to be adopted in recruitment processes and that recruitment processes also contain tacit knowledge sharing. Hiring workforce outside of the water utility is time consuming and expensive, thus expectations for successful hiring will be high. Newcomers should receive extensive orientation not only of the water utility and work procedures but also stakeholders and key partners.

The whole work community has to emotionally commit themselves to the sharing of critical and tacit knowledge and the management and supervisors have the responsibility to encourage and instruct personnel to remember the retention processes. If the working culture and working environment is open, newcomers dare to ask questions and will get professionally instructive replies. Creation of a good sharing atmosphere and trust will encourage knowledge retention. Even so, managers and

supervisors should have situational awareness and confront potential employees who are not willing to share any knowledge.

5.3 Knowledge management practices

5.3.1 Knowledge management at water utilities

In 2011 the participants were asked to tackle a question on knowledge management at water utilities. At a water utility, top management is responsible for setting the approaches and ensuring resources to knowledge management actions. The participants emphasised that with knowledge management issues, the flow is from the bottom, and the top managers cannot hold knowledge among themselves. Knowledge should be managed and tacit knowledge shared in open and trustworthy cultures. A variety of means to manage knowledge at a water utility were listed:

- *Prior to retirement, employees should take part in special development discussions where critical work tasks and vital questions on how to capture and transfer knowledge are covered.*
- *Knowledge management calls for quality management systems or enterprise resources planning or other expert systems, and working and workplace orientation instructions. Regular quality audits ensure that the water utility operates according to the requirements.*
- *Effective orientation needs not only time but also other resources, like the necessary knowledge management tools.*
- *Hiring new personnel should start well in advance so to facilitate knowledge transfer.*
- *Knowledge management is a day-to-day action, which needs attitudinal change in the whole organisation. Teamwork skills and pair work skills are required.*
- *Critical knowledge can be captured during thematic days or years. At large water utilities the themes could be applied on a unit basis, like the network, the treatment facility, etc., and at small water utilities in its entirety.*
- *Learning from mistakes.*
- *Feedback through social media.*

5.3.2 Role of top management in knowledge management

The question on the role of the top management in knowledge management was added in the list of questions in 2011. The answers were grouped as follows:

(i) organisation structures and procedures

(ii) workforce planning and development discussions

(iii) reward and recognition

(iv) open atmosphere and dialog

(v) working together

(vi) miscellaneous.

In the organisation structure and procedures category respondents stressed the leading role of management. Managers should make clear the importance of knowledge management and that every staff member must commit to the transfer of knowledge. Besides launching the initiative of knowledge transfer, the management of a water utility has to keep track of the transfer actions, and create procedures especially for capturing tacit knowledge. The top management has to ensure that knowledge is a common commodity that is advantageous and beneficial for the whole water utility. On the other hand, transfer should elude harmful tacit knowledge. The management is best equipped to direct knowledge management processes and tools, e.g. quality and operation systems.

In the workforce planning and development discussions category, respondents highlighted the importance of workforce management and workforce planning. Human resources departments have to create schemes for retirements and for other staff changes, like promotions and changings of jobs, in advance. Staff changes are inevitable, but management should be prepared to cope with changes. Respondents indicated that sufficient time for workplace orientation should be reserved to ensure efficiency in sharing organisational information and knowledge. Development discussions should also serve as a means of sharing knowledge.

Managers have to consider how their own personnel could develop their competence and skills towards project manager positions. Instead of promoting external recruitment, managers should use internal recruitment and offer leadership training to successors. This is cost effective and could be a motivation trigger for staff and give them an indication for career development positions within their own employer. Other reward and recognition means mentioned dealt with knowledge and tacit knowledge. Transfer actions should be accredited and rewarded visibly. Some of the means expressed were flexible working hours and the possibility to work in expert positions after retirement. Managers are expected to create a culture of trust and openness. They should be open-minded to creative inventions and innovations but at the same time allow best old practices. Knowledge management calls for an active dialog between managers and personnel.

Team spirit and working together are prerequisites for knowledge management at water utilities. Employees should be given time to manage their knowledge and to prime younger ones for their duties. Interestingly, an age-related theme emerged from the miscellaneous category. One respondent reviewed the age questions as follows: ’At the age of 40 to 50 years employees do not tell anyone, at the age of 50 to 55 years employees tell only to their peers, at the age of over 55 years employees tell everyone'.

5.3.3 Activities supporting and rewarding critical knowledge

Time and sharing means and proper tools have to be allocated for critical knowledge sharing activities. Knowledge systems have to be inclusive, for example compulsory timesheets must be in the electronic systems. Participants reported the following means of support for critical knowledge transfer:

- *Organisational and cultural actions: overcome resources and time constraints for master-apprenticeship; recognition of possession of critical knowledge and encouragement of sharing and transferring; improving the attitude of sharing knowledge for those who tend to hold back knowledge;*
- *Tools and materials: quality management systems; critical knowledge documentation would have a positive impact on the importance of knowledge;*
- *Development of competence and skills: workplace orientation: experienced and younger employees work side by side long enough, following the tasks indicated on the orientation check-list; master-apprenticeship: it is essential to use proper support mechanisms so the experienced employee is able to transfer part of the work to the less experienced employee; development of skills for teamwork, including team training; competence improving activities; training working phases to other employees.*

The participants thought that accreditation of work, positive feedback and hailing for good results would further critical knowledge transfer. Having a motivational working environment was also mentioned as something that could accelerate critical knowledge transfer actions. The payroll system was discussed in the sense that a responsible position should include critical knowledge transfer, which in turn should be added into the basic salary.

The following three concrete compensations were identified: (1) water utility respects workers: it is a great privilege to be nominated to the supervisor positions or have a better job title, like senior plumber; (2) flexible workload assignments: flexible working and work-life balance, which sometimes can lead to postponed retirement; easing workload; and (3) monetary recognition: salary raise; initiative bonus; recognition with personal gifts, like golden watches.

Tacit and critical knowledge in water sector cases has been reviewed in Chapter 5. This chapter began by describing how WASLED programme participants understood tacit knowledge and critical knowledge and the ownership of them at water utilities. Thereafter, the capturing and sharing practices were outlined and finally, the management practices, responsibilities of top management and systems to reward employees for sharing knowledge were discussed. These results will be used in triangulation with the results gained at Pori Water. The next chapter presents the findings of this dissertation and provides an account of the evaluation.

6 DISCUSSION AND ASSESSMENT OF THE RESEARCH

The results achieved during the course of the long research period will be explained, compared to the theoretical background discussed in Chapter 3 and assessed in this chapter. The following research questions will be addressed: (i) how do personnel at water utilities interpret the concepts of information, knowledge management and tacit knowledge, and how is knowledge captured and shared; (ii) what information needs do personnel have in performing daily tasks and what acquisition channels do they use; and (iii) what is the role of formal and informal networks in performing daily tasks and gaining new knowledge. The results from the research on tacit knowledge, critical knowledge and knowledge management practices at water utilities gathered from the WASLED programme participants will be used as multiple sources of evidence with the findings from the research at Pori Water.

6.1 Discussion and review of the results

6.1.1 Changes in the physical and operational environment of Pori Water

Being a municipally owned company of the City of Pori, Pori Water provides water and wastewater services both to private households and companies. The organisational structure in 2013 was the same as in 2004, except for the composition of the board, which had become larger due to merges of municipalities. The Pori Water operational organisation chart, which divided the company into the water treatment unit and the network unit, had not changed. The personnel structure remained unchanged, except for the outsourced cleaners. The mission of Pori Water 'to provide water and wastewater services at a competitive price taking into account customers' needs and environmental sustainability' was the same in 2004 and 2013.

Between 2004 and 2013 the area of operation extended and the number of citizens served increased. In 2013 water and wastewater services were offered to about 10 percent more citizens than in 2004. However, the total amount of pumped water into the network was about the same: in 2013 it was under four percent lower than in 2004. The treated wastewater amount was about 12 percent higher in 2013 than in 2004. Industrial water usage, precipitation and the citizens served may be explained by the annual variations, which are quite typical in the water utilities sector.

The most significant finding is the *diminishing workforce*. In 2004 the number of personnel was 94. By the year 2013 the number of personnel had decreased by almost 26 percent down to 70. Several factors, such as retirements, changes in work positions, outsourcing of tasks and termination of employment contracts, explain this finding. The result in diminishing workforce mirror those of Hallikas (2011), who found that 17 percent decrease in the number of personnel took place between

2002 and 2010 at Finnish water utilities. However, the observations in this dissertation showed that downward trending was faster than in her study. New employment contracts have been signed regarding positions that had not existed earlier, like construction and ICT specialist. At this point it should be noted that hiring additional workforce at a water utility is hard because of labour policy regulations municipal entities have to follow.

The results of this study show that the mean age of the interviewed personnel had gone up by three years reaching 50 years in 2013. If the age of 63 is taken as the usual age of retirement, the proportion of the interviewed personnel reaching the retirement age was alarming: in 2004 30 percent and in 2013 48 percent. This finding is consistent with that of literature reviews in Chapter 1 and Chapter 3 dealing with an ageing workforce, especially with those of Vesi ja viemärilaitosyhdistys (2003), Hallikas (2011) and Heino et al. (2011) who found similar trends in ageing personnel. The share of baby boomers (born 1946−1964) and Generation Xers (born 1965−1980) at Pori Water was altogether 79 percent in 2004 and 94 percent in 2013. During both interviews there were only a few Generation Yers (born 1981−1999).

The interviewees had substantially long working experience at Pori Water. In both interviews the mean was 19 years and the range 0−39 years. This result further supports the idea of the personnel's long-term commitment to stay in the organisation, which was one the traits Grigg and Zenzen (2009) listed as the common traits for baby boomers and Generation Xers.

Utilisation of computers has increased at Pori Water. In 2013 79 percent of the employees had personal computers with internet connection, while in 2004 the figure was 56 percent. At the same time the number of employees without a possibility to use computer had declined from 38 percent to 12 percent. This change reflects the general development towards digitalisation in the society.

6.1.2 Information and knowledge management at the individual and utility levels

In this study, the interviewees for the most part did not understand knowledge management as it relates to information, information acquisition, and tacit knowledge. A note of caution is due here since in the Finnish language the word *tieto* means either information or knowledge. The responses in 2004 revealed that 38 percent of the interviewees confused knowledge management with the provision of intangible process information, i.e. becoming informed. The interviewees expected someone to tell them something, preferably something important. Both in 2004 and in 2013 information was interpreted as informing, related to tasks, discussions, sharing and disseminating. A new rather interesting phenomena in information was revealed in 2013, namely something hidden or not heard. It might be explained by the fact that personnel were afraid of missing valuable information or they felt that information and knowledge were intentionally being kept out of their reach. These results might further indicate that personnel want to have a broader understanding of the water utility as a whole entity, and they want to engage themselves in the task-related knowledge

creation processes. The skilled personnel's need to gain more usable information supports this interpretation, too.

The views presented by the interviewees reflect those of Buckland (1991) who divided information to intangible and tangible and entity and process continuums. Becoming informed, which presents intangible process information, was the most of often provided definition, although task-related information, discussions, sharing and disseminating represent intangible and tangible entity information and tangible process information. How the personnel understood information was also in accord with the definition by Devlin (1999), who sees information as linked to context or environment, object or situation, and transmission. Task-related information contained elements of work procedures used at the water utility, which is context and environment bounded. In this respect information has both relevance and purpose as Visscher et al. (2006) stated.

At the utility level respondents were not asked to explain the word knowledge. However, some of the characteristics of knowledge were indirectly detected. On the question of knowledge, the information categories, such as task-related, discussions, sharing and disseminating, share hidden elements closer to knowledge than information. It is obvious that Sveiby's (1997) 'knowledge is capacity to act', Frigo's (2006) 'knowledge is capacity to make effective decision', and Bennet and Bennet's (2011) 'capacity to take effective action' fit well in the water utility as well as Devlin's (1999) interpretation of knowledge as a sum up internalised information and ability to utilise information. The knowledge definition 'information is relevant, actionable and at least based on experiences' by Leonard et al. (2015) is well applicable to the water utility. In this research knowledge was mainly analog and practical, depended on individuals and was transferred in face-to-face communication. These results share same characteristics with Sveiby (1997), and Nonaka and Takeuchi (1995), who made clear distinction between information and knowledge.

Consistent with the literature, this study found out that different forms of knowledge exist at the utility. Explicit knowledge as explained by Allee (2003), Brooking (1996), Davenport and Prusak (2000), Hasanali et al. (2003), Baker et al. (2004), Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011), Tryon (2012), Leonard et al. (2015) existed in various formalised and codified forms. Implicit knowledge existed in operating procedures and corporate culture as observed by Brooking (1996), Tryon (2012) and Leonard et al. (2015). The tenure profiles at the case utility showed long working experiences. The stable co-worker structure and constant positions might relate to the existence of evident knowledge as explained by Blankenship et al. (2008). There are similarities between the types of organisational knowledge found in the results of this study and those presented by Choo (1998), i.e. tacit, ruled-based and cultural type of knowledge was found at the utility. Existence and sharing of tacit knowledge will be discussed in Sub-chapter 6.1.3.

Indigenous knowledge, a term provided by Visscher et al. (2006) for local and traditional knowledge, is also applicable when speaking about task-related knowledge at water utilities. The daily work at

water utilities is characterised by routines and embedded knowledge of treatment processes, water and sewer networks, products, manufacturers and customers. This kind of knowledge develops over time and at the same time improves the professional skills of the personnel. In that sense, it is a question of incremental process of application and interpretation of information as described by Probst et al. (2000).

In 2013 a common view on the results of knowledge management definition was that it is a personal issue and strictly related to their work. Only a few thought that it is information found in formal systems, databases, programmes, etc. In the majority of the cases in 2004, knowledge management was not seen as the utility level issue, because the individual property aspect was emphasised over the organisational property and system information aspects. In 2004 organisational knowledge management was linked to individual tacit knowledge and information given to customers. The interesting, positive finding from the 2013 answers was that leadership and knowledge management and knowledge sharing were clearly understood to benefit the whole utility. Still, respondents valued the knowledge they possessed so much that some of them were unwilling to share it. In 2013 this may have indicated that knowledge is used to secure the job.

Managing knowledge was also seen as a personal issue. Individual information filing systems and the interviewee's own memory were the key elements on the management side. The conclusion from the 2004 research was that on the utility level, the role of knowledge management tools, like customer agreements, invoicing programs and network information management programmes, were not seen as powerful. The research in 2013 reversely showed that the network information system had proven its power to store and transfer knowledge. While in 2004 the network information system was in its initial phase, in 2013 it was well utilised. If the knowledge that long serving employees have about the details of networks and customers is not recorded into management systems, the value of programs as forecasting tools of operation and maintenance will be lost. In 2004 many of the interviewees were conscious of this fact, but the general attitude of some personnel groups towards management systems and knowledge sharing practices ignored this concern about knowledge disappearing. The more open attitude towards knowledge management systems in 2013 might be explained by the fact that access to online information and knowledge sources, and to knowledge management systems, was easier and wider because of the availability of computers; in 2004 62 percent and in 2013 88 percent of the interviewees either had personal computers or had access to shared computers.

At the utility level, there were several ways to share information and knowledge; programs, databases, notice boards, e-mails, personnel bulletins *Vesiposti* and *Karhunpalvelus*, projects and other reports, etc. The most powerful way in 2004 was informal coffee table discussions and other face-to-face contact. Stories were also meaningful, even though they were not actually seen as such. Stories containing elements of mistakes were undervalued, though they teach more valuable lessons than other types of stories. A rather unexpected result was that coffee table discussions did not have the same importance in 2013 as they had in 2004, which may be the result of diminishing

workforce and jobs that required a more hectic pace. Other face-to-face contact during the daily tasks had kept their significance in information and knowledge sharing. In general, formal meetings of teams, groups and shifts were valued more in 2013 than in 2004. The storytelling culture had almost disappeared from the utility, which may be related to the retirements and to the lack of time.

These findings on knowledge management and knowledge sharing match the literature, such as Probst et al. (2000), Awad and Ghaziri (2004), Grigg (2006), Grigg and Zenzen (2009), Dalkir (2011), and The Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011) referred to in Sub-chapters 3.2 through 3.4. The face-to-face contacts, i.e. formal meetings, informal discussions and working together were predominant means for sharing knowledge at the case utility. The literature referred in Sub-chapter 3.3.3 emphasised the power of storytelling in sharing knowledge and creating organisational culture. However, the role of storytelling in this research had decreased between 2004 and 2013. Overall, the results on knowledge management do not build up deeper understanding of the wide context of knowledge management, i.e. how to manage knowledge as a resource or asset as outlined by Probst et al. (2000), Price R.K. (2001), CEN (2004c), Bennet and Bennet (2011) and WHO (2016).

The knowledge management models by Probst et al. (2000) and Weggeman (2004) were only partly applicable in the case of Pori Water. Both models were unsuitable mainly because the organisation's knowledge management strategy was missing, and thus the double-loop back to the goals and core competences did not exist. Knowledge elements like identification, acquisition, development, sharing, utilisation, and retention (in the model of Probst et al.) as well as knowledge need, availability, development, sharing, application, and evaluation (in the model by Weggeman) were somehow traceable at Pori Water. Similarly, CEN's (2004a) knowledge activities – identify, create, store, share, and use – were verified.

The SECI model by Nonaka and Takeuchi (2000) was applicable to Pori Water, not least because many personnel were holding the same posts until they retire. The forms SECI processes took were:

- *socialisation: technical knowledge and skills sharing with co-workers, learning from observing, coffee table discussions, apprenticeship*
- *externalisation: learning through development projects and from written documents*
- *combination: annual and performance reports, learning from best practices of personnel at other water utilities, professional networking, formal office meetings, utilisation of information and communication technology, for example, in maintaining information on network and treatment processes*
- *internalisation: learning-by-doing, mentoring, training events, documents, manuals, oral stories, using equipment and methods.*

The integrated knowledge management strategy model presented by Grigg and Zenzen (2009) was for the most part applicable in the case of Pori Water. The key elements of the model were knowledge, knowledge management system, workforce and organisational work. All the elements

can be traced at Pori Water, although the lack of knowledge management strategy leaves the cycle incomplete.

6.1.3 Tacit knowledge and sharing practices at the utility

Tacit knowledge was interpreted in several ways at the utility. As a concept it did not mean anything to almost half of the interviewees in 2004, but when interviewees were asked to explain practical experience-based knowledge, all knew what that was. Unexpectedly, every fifth interviewee thought that tacit means that you do not reveal your information and knowledge. This reflects the value of all knowledge, especially tacit knowledge, to an individual. An interesting finding from the 2013 interviews was that the concept of tacit knowledge was very familiar to over 80 percent of the respondents. Most probably this result is due to the increased media coverage of tacit knowledge and retirement boom during the last ten years. Various media have alerted that, unless preventative measures are taken, tacit knowledge walks out of the office with retiring personnel. Both in 2004 and in 2013 tacit knowledge was interpreted similarly; it related to work experience, craftsmanship, co-workers, something in your head and something not told to anyone. These interpretations are in line with previous works by several authors referred to in Sub-chapter 3.2.2, like Boiral (2002), CEN (2004c) and Dalkir (2011), who emphasised experiences to be the key to acquire tacit knowledge. Craftsmanship has been gained during tens of years of working at the same positions with the same co-workers. Thus, developed expertise and 'something in your head' together reflect the existence of deep smarts, concept defined by Leonard and Swap (2004). The results of tacit knowledge and expertise in this research further support the idea of know-how by Choo (1998), Lubit (2001), Blankenship et al. (2008) and Dalkir (2011). The expressed statement by one of the interviewees 'There is not a single problem that the more experienced workers could not solve' match well with the properties given to tacit knowledge by Dalkir (2011), i.e. ability to adapt to the changed circumstances, and to deal with new and exceptional situations.

In this research most tacit knowledge was seen to be integrated into the work experience and learning-by-doing things together. Sharing was seen to take place mainly between closest co-workers and during the actual work, but sharing between other workers and units was seen to be insufficient. Understanding may play a role in the sharing of tacit knowledge between separate units because colleagues working at different units may not be familiar with what people in other units already know. Yet, sharing of tacit knowledge was thought to depend mainly on the sharing culture and the atmosphere. Especially the small teams or pairs of co-workers were very familiar with the tasks and knowledge needed in performing the work. Those teams shared tacit knowledge during working procedures, they knew the culture and, above all, knew each other, which made tacit knowledge transfer easier. In 2004 the alarming thing was that some technical data and information on the treatment plant, network or equipment was said to be tacit but was nevertheless not recorded in any database or document. It was somewhat surprising that in 2013 personnel still mentioned the lack of technical data or information. A possible explanation for this may be the missing or incomplete documentation of water and wastewater systems that have been merged to Pori Water.

The findings of work experience, collaboration and learning-by-doing things together is contrary to previous literature, i.e. Nonaka and Takeuchi (1995), Nonaka et al. (2000), Choo (1998), Leonard and Swap (2004), CEN (2004c) and Dalkir (2011).

The constraints in sharing knowledge were listed in Table 3.11. The research results verify that the processes of exchanging knowledge face several barriers related to organisations, individuals or cultures. Lack of up-to-date information on water and wastewaters systems, non-existent strategy for managing knowledge, and unwillingness to share knowledge were among the most important concerns at the water utility. Cultural characteristics and barriers were not regarded as significant challenges, except for different generations and their ability to speak the same language.

An expected result was that tacit knowledge was associated with process noises, smells, colours, information on underground structures, equipment and systems, information on customers and contractors, etc. This result is quite similar to Boiral's (2002) findings on the role of tacit knowledge in the chemical industry. Somehow these phenomena should be documented, and the Trimble NIS (in 2004 Tekla Xpipe) water and wastewater network information system design application will provide a powerful tool for managing network information. The need for documentation and making knowledge available broadly supports the work of the Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011) in the area of operating information and it's retention. In communication, especially between co-workers or teams, the voice, facial expressions, body-language, emotions, etc. transmit much tacit knowledge.

One of the most important factors hindering the sharing of tacit knowledge was the ageing personnel at the utility. Assuming that employees retire at the age of 63 and that those considering retirement will leave the workplace within the next five to ten years, from the 2004 interviewees 31 percent and from the 2013 interviewees about half (48%) will leave the utility. This finding is consistent with several authors who have pointed out the ageing of personnel in organisations, including the Finnish research results presented by Vesi- ja viemärilaitosyhdistys (2003), Hallikas (2011) and Heino et al. (2011). The saying about knowledge walking out the door (Leonard and Swap 2004, Post and Breen 2005 and Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee 2011) applies very well to this utility. An effort must be made to capture leaving employees' undocumented knowledge in time. Closing of the employee gap should start soon, so that naturally favourable conditions for sharing could be created. Vaahtio's (2005, 90−91) opinion on the ageing problem and tacit knowledge is that the role of tacit knowledge should be emphasised, but not too much. However, in the case of this utility it should receive great emphasis.

The results of this study are in agreement with Vaahtio's (2005, 91) other comment that tacit knowledge is created automatically during ageing, although it takes time to develop it. This study also showed that the generation gap in the sharing of tacit and other knowledge is as big a problem as ageing itself. The statement, 'The work is so routine that no younger guy should come and tell me how it should be done', by one of the interviewees carries the same message as the comment by

Vaahtio (2005) and (Lubit 2001), 'Things have always been done this way'. If the intention is only to share slander, rumours and obsessive attitudes, it might be better that tacit knowledge is not shared at all.

6.1.4 Information needs and sources of the water utility personnel

The first research question also included the definition for information acquisition, which the interviewees understood clearly in both interviews. Information acquisition was connected to individuals actively acquiring information, information acquired when needed, various means of acquiring information and information acquisition for improving skills or performing tasks. In 2004 the interviewees valued personal contacts highly; 75 percent used personal contact first when in need of information. The most important finding on information acquisition was that in 2013 only 25 percent used personal contacts first. In most cases information was acquired individually and from a combination of multiple information sources. The internet and Google were emphasised, but none of the respondents commented on the validity of that type of information. Interviewees also indicated that they lack the support from previous employees who have retired. It can therefore be assumed that retirees had been central informants, whose information and knowledge should have been retained.

The second research question dealt with the type of information personnel needs in their daily tasks, what sources do they use to search for it, and how the situation in 2013 differed from the year 2004. The type of information considered included decisions of Pori Water, terms and conditions of employment, terms of purchase, legislation, technical information on equipment, and other information. Information sources included personal contacts, document repositories, databases, electronic forums, etc. One self-explanatory finding was that information needs and usage at the utility were versatile and depended on the tasks performed by the employees. One interesting finding at the utility level was an increase in all types of information personnel needed in their daily tasks. This result could be due to rearrangement of tasks, or because of diminishing workforce.

The use of information on terms and conditions of employment and on terms of purchase had increased most. The use of information on the former increased from 33 percent to 55 percent, and information on the latter from 44 percent to 55 percent, respectively in 2004 and in 2013. The employees who dealt with employment contracts and purchases needed related information. Purchase information is also needed in certain tasks. Those who either buy or suggest purchases need information on terms of purchase. Use of legislative information increased from 56 percent in 2004 to 61 percent in 2013. It was also interesting to find that interviewees could name several acts and decrees they need in their work.

Information related to decisions made was valued quite differently. A rather surprising finding was that decisions either made by Pori Water or dealing with the utility did not have much value for 45 percent in 2004 and 39 percent in 2013 of the interviewees. Such decisions were presupposed to

receive much more interest. In 2013 some respondents specified that decisions on tariff structure, terms of delivery, and contractual terms are the most important.

All personnel groups needed plenty of technical information and equipment specifications. In 2013 this information was needed by 94 percent of the personnel, while in 2004 the figure was 93 percent. This is not surprising, because almost every employee has to use some kind of equipment. Also unsurprising is the result that indicated secretaries – whose tasks are primarily administrative – needed somewhat less technical information than other personnel groups.

In the other information category, interviewees in 2013 needed more focused information on performance factors and real-time operational information than was brought up in 2004. This finding might be explained by the fact that they are interested to know the performance of the utility, develop their work further and show responsibility in their tasks.

Use of different information sources also varied based on personnel groups and units. The personnel got information through several channels: e-mails, the City of Pori's intranet, the internet, by hand delivery to the coffee table or from the notice board. Internal communication was crucial to the personnel of Pori Water. They relied more on their own information and that of colleagues before turning to other internal sources like the library or document collections. From the results it can be concluded that the role of personal collections had increased between 2004 and 2013; daily users had increased from 23 percent to 39 percent and non-users decreased from 23 percent to 15 percent. This result may be explained by the fact that availability of personal computers increased between those years.

The most interesting finding was that closest co-workers kept the position as the most widely used information source in every unit: almost all interviewees had personal contact with their co-workers and respective groups weekly. In 2004 the figure was 98 percent and in 2013 there was a slight decrease to 91 percent. However, at the same time the share of no contact to co-workers had increased from two percent to six percent. In the case of discussions with co-workers of other units, no contact increased from 11 percent to 18 percent. This is partly explained by the fact that employees stick to one facility and do not have many chances to visit other units.

In 2004 almost half (48%) of the interviewees had no contact with personnel from other water utilities. The role of storekeepers in information searching and delivering was enormous. They delivered information and technical details on advance material, plumbing equipment, fittings, etc. The store seemed to be the point of convergence for almost all personnel groups and units. Similarly, the supervisors were the persons to whom teams turned when they needed information. The utility seemed to have a couple of persons whom the other workers contacted if they needed information or guidance. The results in 2013 showed that other water utilities were still contacted seldom, but the proportion claiming they had no contact had dropped to 38 percent. At Pori Water the store was no longer the key meeting point, while the supervisors and a couple of other persons were key informants. Contacts with colleagues and other experts outside Pori Water had changed during

the years. While in 2004 there were many personnel groups who had daily contact outside Pori Water, in 2013 none had daily contact, monthly contact had dropped from 34 percent to 24 percent and no contact from 34 percent to 27 percent.

The use of the internet as an information source changed remarkably. In 2013 the internet was used actively by more than half (52%) of the interviewees, which is double the amount in 2004. Also the proportion of non-users had changed; from 41 percent in 2004 to 27 percent in 2013. This result is clearly explained by the fact that availability of personal computers had increased during the years. However, chat channels and discussion forums were not used to acquire information. In 2004 no one used them and in 2013 only three percent used them on a weekly basis.

Professional literature, Pori Water internal reports, external reports, conference papers and journals were used quite seldom both in 2004 and in 2013. In fact, the share of non-users had increased from 59 percent to 70 percent with professional literature, from 20 percent to 52 percent with internal reports, from 55 percent to 61 percent with external reports, from 59 percent to 61 percent with conference papers, and from 61 percent to 79 with journals, respectively in 2004 and in 2013. In 2004 reasons for the low usage were the unavailability of books, because the so-called document collection of the utility only had a few professional books, and the checking of details or technologies from books was regarded as unnecessary. Some technical journals were available at the units, but access to them was unequal because the journals did not circulate from one place to the other. These findings were valid also in 2013. The overall trend was that traditional, i.e. printed, publications and journals were still important sources of knowledge. However, the main reason for not using printed copies of professional literature and journals may be the increased use of online sources when searching for information, for example, about new technological applications or new equipment. Other possible reasons for not using books and journals might be that there is not enough time or motivation to do so. One reason for the low usage of external and internal reports might be the diminished amount of research or development projects. Generally, it could be concluded that the lower in the hierarchical structure the employee was, the less professional material he or she would read. Instead, those persons turned to their supervisor for further information.

Use of equipment manuals and brochures slightly increased in 2013 compared to 2004. On the other hand, the proportion of personnel who did not need equipment manuals or brochures increased from 20 percent to 39 percent. This outcome is contradictory to the finding described earlier on the type of needed information; almost all (93% in 2004 and 93% in 2013) needed technical and equipment information. This difference can be explained by the fact that information source was related to printed copies of manuals and brochures in 2004 and mainly to digital copies available online in 2013. When performing their daily tasks and needing technical and equipment information, personnel either asked their co-workers or called manufacturers or service providers.

The role of standards and patents as sources of information was minor. Standards were mainly used in standardised laboratory tests and official documentation formats. The rather surprising result was the use of patents; six percent used them daily to look for process and equipment developments.

In 2004 the use of electronic databases was mainly limited to day-to-day activities involving network and customer information, while in 2013 the use of electronic databases had become more common. Twenty-seven percent used them daily and 12 percent weekly in 2013. Respective figures from 2004 were 15 percent and 7 percent. The proportion of non-users decreased by 9 percent, reaching 55 percent. The most obvious explanation for this was the digitalised maps, process and network data and customer information.

The role of trade unions and professional associations as information sources was dichotomous. Corporate membership in FIWA provides information on several water and wastewater utility issues, but individual membership in trade unions is not a means of collecting information. Professional associations offer an excellent possibility to obtain context-specific information, but membership in them had decreased between 2004 and 2013.

The results on information sources are similar to those mentioned by Cross and Parker (2004). The interviewees preferred their closest personal sources, although the primary source might have been somewhere else in the information chain, for example, in printed or electronic form.

In summary the findings from inquiring about information needs indicate that utility personnel use plenty of different types of information in their daily tasks. They also acquire it from various sources, although the role of the internet has increased significantly. The results on information needs and sources may provide understanding of the complex and challenging environment in which water utilities nowadays operate.

6.1.5 Networking of individuals and organisations

The third research question focused on the formal and informal networks and their utilisation in performing daily tasks and obtaining new knowledge. The networks were explored from the perspectives of professional associations and trade unions, and task-related networks.

At the organisational level Pori Water is a member of the Finnish Water Utilities Association (FIWA), from where the utility can acquire means to develop personnel's professional skills. However, the extent that FIWA's services are utilised did not emerge during the interviews.

At the individual level, trade unions and professional associations only represent membership type activity. Although the total number of trade unions was as high in 2013 as in 2004, the networking possibilities were utilised by the chief shop stewards. In 2013 there were 11 trade unions counted, but none of interviewees utilised them as a source of professional information for their daily tasks. Professional associations were seen to play a role in networking only by six interviewees (10%) in

2004 and by two interviewees (6%) in 2013. However, none of these associations directly represented the water and environmental engineering field.

This finding is rather disappointing. The effect of trade unions as information and knowledge carriers was not recognised. Similarly, only a few indicated that professional associations offered possibilities to develop knowledge and skills, and network with professional colleagues. Overall, the findings in trade union and professional association networks indicate that assistance for solving professional challenges is not sought from these sources.

The key finding on the task-related networks was that the most important network consists of *closest co-workers* at Pori Water. These networks were used to solve work-based practical problems. This finding was similar to that of Cohen and Prusak (2001): the main interactions are with closest co-workers, and with those performing normal tasks. The type of these interactions was similar to the awareness network presented by Cross and Parker (2004). The access network also existed at Pori Water, especially when assistance was asked of employees who might reach other experts.

Cross and Parker (2004) mention that in communication networks the key co-ordinating persons are secretaries and office managers, but they do not deal with strategic group work, for example, solving complex problems. This study also showed that both in 2004 and in 2013 the role of administrative staff, planning officers, foremen and secretaries was important in delivering information to other personnel groups. The role of the store and storekeepers had changed significantly; in 2013 the store was no longer a key contact and lively conversation point.

From the results gathered in 2004 and in 2013 it can be concluded that external networks at Pori Water were large, quite stable and included multiple sectors. The external networks consisted of organisations of the City of Pori, contractors, customers, laboratories, regional environment offices, wholesalers, companies, consulting companies, chemical suppliers, equipment manufacturers, software developers and service providers, contractors, laboratories, police and rescue services, other water utilities, FIWA, etc. The interviews in 2004 and in 2013 did not reveal any global networks or membership in international associations.

The professional networks consisted of task-relevant contacts, and every interviewee had individual contact networks. In 2004 the external networks of some personnel groups extended to other local offices, organisations, and companies, but very few had professional contacts outside the City of Pori. The situation in 2013 was somewhat different, since most of the employees also had nationwide contacts. In fact, the number of contacted organisations, associations, and companies had increased. Especially the role of software companies for the source of information and guidance was greater in 2013 than in 2004.

The long-term co-operation with other waterworks was pointed out in several interviews in 2004. That co-operation included both professional and informal activities. The results from 2013 interviews revealed that there was no longer regular contact with other water utilities. It can therefore

be assumed that these contacts might have disappeared because of the retirement boom, inadequate transfer of relationships and lack of time.

The findings of external networks reflect the vast area of operations that Pori Water oversees. External networks are essential when a water and wastewater utility is the provider of services according to laws and regulations to private and industrial customers. The challenge is not only to perform daily tasks, but also to gain new knowledge on, for example, software programs, equipment, materials, and new technologies.

6.1.6 Development of the organisation and personnel

In the 2013 interviews the personnel had received a basic or professional education on average 27 years prior, but the timespan ranged from a couple of months to 47 years. The average had risen by two years from 2004. Pori Water organises in-house further trainings for their personnel annually. About 70 percent of the personnel attended annual training events in 2004 and in 2013, while the proportion of non-attending personnel had gone up significantly, from 18 percent to 30 percent. This last trend is a rather surprising result, which may be explained partly by scarcity of time because of hectic work and partly by the lack of interesting topics or by previously disappointing training sessions.

The personnel of Pori Water actively attended training events organised in Finland. Annual participation had gone up from 38 percent in 2004 to 52 percent in 2013. More than half of the interviewees had a chance to learn new skills and develop their knowledge. However, at the same time 42 percent of the respondents did not attend training events organised in Finland. If this is compared to the 18 percent in 2004, the change is notable and is in contradiction to the recommendations given in a 2007 study on development of Finnish water services. This finding could be due to retirement, the work position or the lack of motivation. Attending training events organised abroad was only a marginal factor. Of the 2004 interviewees, 80 percent had never attended training events abroad, while in 2013 the figure had risen to 91 percent. This finding was quite anticipated because water utility is local and does not take part in international projects.

The study showed (Table 6.1) that the role of further training was seen as essential for increasing knowledge. Both participation in conferences and staff training had increased in their importance in 2013 compared to the figures in 2004, since 63 percent and 48 percent, respectively, said that conferences and trainings increase knowledge. More emphasis should be placed on required training, how to explain training objectives to the personnel, and how to organise training events. Some internal training events, like leadership and customer service programmes, seem to have failed partially because the personnel did not see the relevance in regards to their own tasks. Also, the training format should be developed to meet the expectations of the personnel: one of the interviewees suggested that special equipment training should be organised so that an experienced person from another organisation could provide guidance on site. Internal transfers and job-rotation result in effective training between master and apprentice. Above all, personnel have to be

convinced and must understand and accept that in-house mobility and life-long training are the keys to their continued employment at Pori Water, and to the development and skilful performance of the organisation.

Engaging new, qualified personnel had lost a little of its importance as a good or very good means to increase knowledge at Pori Water. The interviewed personnel included only a few new recruitments even though the utility personnel had downsized by some 26 percent between 2004 and 2013. This could be explained by the fact that the tasks had been outsourced and some remaining tasks had been rearranged. Another possible explanation for this might be that hiring new personnel is a formal bureaucratic process, because the status of the utility as an external corporate entity of the City of Pori limits independent staff policy.

An interesting finding from the results is that almost half (48%) of the interviewees in 2013 did not see any knowledge increase at the utility by ordering commissioned services from, for example, consulting companies. It seems possible that these results are due to the fact that the need for subcontracts had diminished over the years because of fewer utility intensification projects. However, the other research and development actions were regarded as good or very good means to increase knowledge by every fourth respondent in both interviewees. Similarly, every fourth respondent valued customer interviews or surveys as good or very good means to increase knowledge.

The result of benchmarking against other water utilities parallels with the findings on information sources given in Sub-chapter 6.1.5. Benchmarking is important, but if there are few possibilities to visit other utilities, the good knowledge transfer loses its strength. Thus, it may be concluded that the decrease from 65 percent to 48 percent, respectively in 2004 and 2013, reflects the fewer contacts at other water utilities.

Both in 2004 and in 2013 almost all interviewees worried about the ageing problem of the utility. The retirement boom was still present at the utility in 2013, so in that sense the situation had not changed from the situation in 2004. Of the interviewees in 2013 almost half (48%) were going to retire within 5 to 10 years. The knowledge of employees in this situation should be retained. Several personnel groups acutely needed qualified people. According to the literature, 80–90 percent of the skills needed in daily tasks are learned in the workplace. Especially the newcomers should get sufficient guidance and introduction to the work and organisation culture. This, of course, presumes that the utility's knowledge sharing atmosphere is open.

Depending on the task, the interviewees said that a newcomer will reach the skill level of an experienced co-worker within a few weeks, half a year, one year, five years, etc. Maybe he or she will have to learn by himself or herself what others already know. This finding was partly similar to what Toivonen and Asikainen (2004, 33) found about newcomer introduction to organisation procedures: usually it deals with general issues of the organisation, and in the worst case they have to find necessary information themselves.

Table 6.1 Effect of different means to increase knowledge at Pori Water in 2004 and in 2013. Percentages indicate the share of interviewees who replied either 'good' or 'very good' effect of means on knowledge increase or 'no effect' of means on knowledge increase.

Means	**Good or very good effect on knowledge increase**			**No effect on knowledge increase**		
	2004 %	**2013 %**	**Change**	**2004 %**	**2013 %**	**Change**
Engaging new, qualified staff	35	30	↓	7	3	↓
Ordering services from consultants	13	18	↑	18	48	↑
Contacts with manufacturers and service providers	33	30	↓	8	15	↑
Equipment purchases	33	36	↑	11	18	↑
Participation in conferences, etc.	49	63	↑	2	0	↓
Publications and journals	28	54	↑	5	15	↑
Computer programs and licences	26	18	↓	8	21	↑
Research and development	25	24	↓	3	5	↑
Staff training	33	48	↑	7	9	↑
Customer interviews/ questionnaires	26	24	↓	7	9	↑
Benchmarking against other water utilities	65	48	↓	0	9	↑

6.1.7 Multiple evidence of tacit knowledge and knowledge management

Multiple evidence of tacit and knowledge management was gathered to gain in-depth understanding of knowledge management practices at water utilities in Finland. Very little was found in the literature on tacit knowledge and knowledge management particularly in Finnish water utilities, thus the findings from Pori Water and from the WASLED programmes are rather interesting. The triangulation of tacit and critical knowledge issues at water utilities and in water sector actors provided confirmation to several research findings achieved at the case water utility. The triangulation further supports the value of knowledge and tacit knowledge both for individual employees at water utilities as well as for the whole water sector. Knowledge and tacit knowledge management at Finnish water utilities should be valued more and particular attention given to concrete actions in capturing and sharing activities. Ageing of the personnel was seen as one of the major challenges. Anticipation is needed in workforce planning and in recruitment of new personnel for water utilities.

At water utilities tacit knowledge was associated to the distribution network, the water utility as a whole, processes, operation and maintenance practices, collection of water samples, and the history of the water utility. The results of this research indicate that the distribution network is the most vulnerable part of the whole water utility. Besides, some 80 percent of the assets of a water utility are in the networks. Information on distribution network locations, pipe materials, installation practices,

etc. might be only in the heads of personnel. Thus, that knowledge is regarded as both tacit and critical and it should be captured and made explicit. Similarly, water and wastewater treatment processes carry tacit knowledge in operation and maintenance practices and in extraordinary situations. Social networks, customers and their needs, social skills of personnel and the organisational culture play in tacit knowledge. Other potential sources of tacit knowledge identified were the huge historical data and information collection, which have not been analysed. This study confirmed that employees who have worked years in the utility associated tacit knowledge with several things, e.g. noises, smells and colours. In addition, tacit knowledge included information on underground structures, equipment and systems as well as information on customers and contractors. These findings broadly support the findings at Pori Water. Organisational characteristics and prevailing cultures incorporate tacit knowledge, as well as stakeholder networks.

Regarding the question of possession of tacit knowledge, this study found that every employee of the water utility has tacit knowledge, but especially experienced co-workers with long-term work history, those who will retire in a short time, and those who are already retired. Tacit knowledge should be externalised and articulated into explicit knowledge. Water utilities should also note that their stakeholders, such as contractors, public authorities, manufacturers and suppliers, have tacit knowledge of the utility, too. These triangulation results support evidence from the Pori Water case that knowledge and especially tacit knowledge rely on work experience, craftsmanship and co-workers. Every employee at a water utility has a huge amount of knowledge and tacit knowledge and they are proud of their ability to make effective problem solving decisions. The results of both from the WASLED and Pori Water emphasised the importance of capturing knowledge and tacit knowledge from the experienced employees and from the already retired ones.

Several means were indicated to create possibilities for sharing tacit knowledge. Documentation, formal meetings, smart questioning, informal discussions, master-apprenticeship systems, job rotation, as well as training and development projects have been widely used at water utilities. A note of caution is needed here since these means not only share tacit knowledge, but also explicit knowledge. Quality management and operation systems, as well as audit and workforce planning are the newer means applied at utilities. Triangulation produced results, which corroborate the findings of the inquiry at Pori Water. In both cases knowledge management tools, like pipeline design applications, have proven to be powerful documentation systems, which should be utilised more efficiently.

The results further support the idea of retaining knowledge, especially tacit knowledge, at water utilities with internal recruitment, thus promoting internal career development. Expectations for successful recruitment outside the utility are high, and newcomers should have extensive orientation not only regarding the utility's internal matters, but also outside the boundaries, in terms of stakeholders and the public. The newcomers' orientation was also emphasised at the Pori Water.

In this research it was clear that the top management should take responsibility of knowledge management at the utility. They should set strategies and approaches for knowledge management actions and ensure time allocations and tools for knowledge sharing. It is important to specify which kind of knowledge is valuable and worth retaining from the information overload. Knowledge sharing depends on the organisational culture, since according to literature, an open and trustworthy culture supports effective knowledge transfer and retaining. This research indicates various means used to capture, share and retain knowledge: exit interviews, quality management systems, enterprise resources planning or other expert systems, working and workplace orientation instructions, effective orientation practices, team and pair work skills development, thematic days, learning from best practices and mistakes, feedback through social media, etc. Capturing and sharing knowledge, as well as retaining knowledge, calls for commitment and attitude changes in willingness to share. Occasionally, knowledge transfer might need a visible reward or recognition measures.

Critical knowledge was dealt with widely at the WASLED training sessions and the participants shared the common view that critical knowledge is both vulnerable and crucial to the success of water utilities. According to the participants any kind of knowledge, explicit, implicit or tacit, can be critical. The amount of critical knowledge is huge and sometimes it is lost in the information overload or converted to tacit knowledge.

A number of tools were mentioned for capturing the critical knowledge: risk analysis, anticipatory risk management, learning from mistakes and best practices, long-term data collection and statistical applications, strategy processes, total quality management systems and operating instructions, human resources policies, development discussions, observing of employees, training for emergency preparedness, benchmarking other water utilities, performance metrics, learning from best practices and workplace health promotion activities. An interesting finding was that informal discussions during coffee breaks and free-time activities could reveal critical knowledge. With the support of the continuity management tool, called HUOVI Analysis, Finnish water utilities can do maturity analysis, analyse their own water utilities operational continuity level, manage operational disruptions and ensure the availability of core services to citizens and customers. It also provides analyses to identify critical weaknesses and perceive threats.

Means to share critical knowledge are the same as sharing tacit knowledge or knowledge in general. However, documentation was emphasised over the other means, i.e. discussions and meetings, development projects, job rotation and master-apprenticeship. Critical knowledge transfer can be fostered by accreditation of work, positive feedback, rewarding good results and creating environment that motivates transfer.

6.2 Self-assessment of the research

The research theme of this dissertation is interesting, but at the same time challenging. From 2004 to 2013 a considerable amount of documents dealing with knowledge management, tacit knowledge, ageing of the workforce, etc. have been written. Unfortunately, both internationally and in Finland, the situation with documents dealing with knowledge management issues at water utilities is very small. Thus, the discussion between theory and empirical results is not well balanced.

A deeper understanding of the research questions has been fairly well achieved. The answer to the first research question, how the personnel from a water utility interpret the key elements of knowledge management and how knowledge is captured and shared, has been well achieved, although what types of tacit knowledge exist in the utility should have gained more attention. The second research question tackled the types of information personnel need in their daily tasks and what sources they use to search for it. This objective was reached and the change patterns in the use of information and changes between 2004 and 2013 have been explained. The third research question deals with formal and informal networks of the personnel, which were traced with the main finding that internal and personal networks were important.

The research settings worked quite well. The semi-structured questionnaire, which contained also open-ended questions, was well-designed although there were too many questions. Perhaps more emphasis should have been on knowledge sharing activities, and in that case, a thematic interview would have worked better. However, the researcher did not change the questionnaire because the longitudinal research setting would have been missed. In the case of some questions, like question 18, it would have been better to have fewer optional answers. On the other hand, this may have resulted in too wide of a distribution of the answers. The open question on tacit knowledge sharing (question 28) was a very good question because it raised a good deal of spontaneous discussion on organisation culture, learning and sharing, and attitudes. The results on internal (question 23) and external (question 26) professional contacts depicted the extent of networking with several stakeholders. The respondents willingly revealed the contacted organisations while withholding the names of the contact persons in the organisations.

The interviews at Pori Water were a positive experience for the researcher. The rather long time spent on a single interview ensured that mutual trust could be created and the interviewees could feel relaxed. There was also time to freely discuss other issues, which helped shed light, for example, on tacit knowledge. The five-month data collection period in 2004 was rather long, and that may have had some effect on the answers, especially those involving definitions. In 2013 the interviews were done in two months, which worked much better, although it was harder for the researcher to lead several discussions a day.

The use of multiple sources of evidence gathered from the WASLED programme participants was important for the trustworthiness of the results. Group sessions took place on a fairly tight schedule

in 2010 and in 2011. The experience of this type of information collection was also a good experience that provided useful information and knowledge of water utilities.

This research was conducted between 2004 and 2013. Perhaps the most challenging component of the research was the huge amount of data, information and knowledge. Thus, one of threats proved to be true in this research: how to create the most important summaries of the broad phenomena of knowledge management at water utilities. Further research is definitely needed to help water utilities and water sector actors to develop more effective knowledge management plans for sustainable performance.

6.3 Assessment of reliability, validity and ethical compliance of the research

The reliability of the research expresses the consistence and replicability, i.e. someone else could replicate the results by following the procedure described in this dissertation.

The number of interviews at Pori Water was high; sixty-one employees (65% of the workforce) were interviewed in 2004 and 33 (47% of the workforce) in 2013. These figures are excellent, particularly since participation in interviews was voluntary. The large number of interviewees guaranteed that all personnel groups and individuals had equal possibility to give their valuable comments on the research topic. The cohort in 2013 had 26 persons who were interviewed also in the first phase in 2004, but the majority of them did not remember being interviewed earlier. It can therefore be assumed that the personnel's interpretations on knowledge-related concepts reflect purely their own conceptions, and there is no inconsistency between the results in 2004 and in 2013. During the WASLED programme phases in 2010 and in 2011, respectively 22 participants and 15 participants from various water authorities, organisations, associations and water utilities attended the group sessions.

As to the reliability of the results on Pori Water, they are sound. In fact, they give a clear picture of the information and knowledge needs, appropriate sharing channels, and vast contact networks the personnel need in performing their daily tasks. Results also show their understanding of knowledge management and tacit knowledge and the importance of retention of knowledge. The results from WASLED sessions broadly support the findings from Pori Water.

The research is valid in the sense that it reflects the reality and understanding of the utility personnel. Construct validity refers to how well the used measures, such as research questionnaires, provide an accurate representation of the things they are supposed to measure. In this study the validity strategy used in qualitative research is based on multiple sources of evidence, i.e. triangulation was utilised to gain in-depth understanding of the phenomena. Multiple sources included the personnel of the case utility Pori Water and the WASLED programme participants. Multiple sources also

provided multiple interpretations of knowledge management, tacit knowledge and knowledge retention. With the use of multiple sources of evidence, the construct validity of the research was strengthened and its trustworthiness increased.

From the external validity point of view, the results of this thesis are neither universally applicable nor directly applicable to other water utilities of similar size. Each water utility has its own structures, processes and cultures, so they should be assessed in their own local environments. However, the research points out for the first time the information needs and acquisition channels of a Finnish water utility's personnel. Also, the interpretations and practices of knowledge management, tacit knowledge and knowledge retention at water utilities are particular and represent Finnish water utilities personnel's conceptions widely. It is possible, therefore, that the findings might have important implications for developing knowledge management at water utilities.

The ethical compliance of this research is based on responsible conduct guidelines and ethical principles of research adopted in the humanities and social and behavioural sciences. These guidelines have been followed during the entire research process. The research has been conducted with integrity, meticulousness and accuracy. Methods used and data gathered are based on scientific practice, and the results are communicated publicly in this dissertation. The previous research work has been acknowledged and the dissertation meets the standards for scientific knowledge. The permit to conduct research at Pori Water was acquired in both interview phases and the permit to conduct research at the WASLED programmes has been acquired for the 2010 and 2011 courses. The researcher has been aware of the rights and responsibilities of the research work. The interviewees and training participants have been informed about their rights. Organisations and foundations granted finance for the first phase of the research from 2004 to 2006. Their support is highly acknowledged. Employees at Pori Water and participants at the WASLED programmes gave their valuable time in the interviews in 2004 and in 2013 and in training sessions in 2010 and in 2011. Their kind support is appreciated.

The first ethical principle, *respect the autonomy and voluntary participation of persons*, was executed by getting permission to do the research and interviews at Pori Water. Both in 2004 and 2013 the permission was granted by the organisation's managing director. Before the data collection started in 2004 and 2013 an information sheet written by the researcher was given to the personnel of Pori Water by the managing director. The information sheet contained background information about the research, its objectives, topics to be discussed during the interviews, and handling the results. Voluntariness, confidentiality of the discussions and anonymity in handling the results were emphasised in the information letter and at the beginning of every interview. The interviewees participated in the research on a voluntary basis. Permission to record the interviews was asked before each interview started. Interviewee had the possibility to stop the interview or refuse to answer at any point.

The second principle, *avoid harm, i.e. treat persons with respect and dignity*, was assured in interviews. A quiet, peaceful room was used to guarantee privacy during the discussions. Interviewees were treated with respect and appreciation for their answers. Sometimes interviewees wanted to discuss topics or incidences perhaps not directly linked to the interview questions. They were given time for that, because side tracks brought up new interesting topics.

Data and information gathered during the interviews was stored in a computer used only by the researcher, and the recording tapes were stored in a place that no one else had access to. The research materials will be stored until the public examination of the thesis has taken place. After that all materials related to tape recorded interviews will be destroyed. The top management of Pori Water re-examined the research results and approved for it to be publicly presented. The procedure on handling interview material fulfils the last principle, *protect privacy and protect data in publication*.

Similarly, the WASLED leaders and participants were contacted to get the permission to do research and organise discussions during the training sessions. The voluntary participation was emphasised to the participants before the sessions. The WASLED participants were treated with respect and appreciation for their contribution to the research. The discussions were held in an open discussion atmosphere and the outcomes were summarised briefly at the end of each session. Data collected on sheets was analysed anonymously and stored in a computer.

6.4 Dissemination and utilisation of the results

This dissertation deals with knowledge management and retention of knowledge in the water utility sector. Although the findings relate mainly to one case utility, Pori Water, the results provide a better understanding of the complex and challenging knowledge environment of water utilities in Finland today. Particularly the findings of the information needs, acquisition channels and knowledge sharing benefit Pori Water in, for example, the development of concreate actions for organisational knowledge management processes and procedures, and the development of a sustainable human resources programme. Since Pori Water is an external corporate entity of the City of Pori, the decision making body, the Board of Pori Water should be informed about the research findings.

The findings could be useful to other Finnish water utilities and to the Finnish Water Utilities Association (FIWA) as the co-operation association of water and wastewater utilities and collaborating companies. It is vital that utilities finally raise awareness of the ageing of the personnel and knowledge retention and start proactive measures in due course.

The research has evoked many new research needs, which may be in the interest of other scientists. Some of the results were publicly presented at the 20th CIB World Building Congress WBC 2016 in June 2016 in Tampere, Finland. The peer-reviewed conference presentation under the title ‘Importance of Retaining Knowledge at Water Works − Findings from Finnish Water Works’ was

published in the WBC16 Proceedings, Volume II: Environmental Opportunities and Challenges, Constructing Commitment and Acknowledging Human Experiences (p. 341−352). It was published in the Report 18 of Tampere University of Technology, Department of Civil Engineering, Construction Management and Economics.

7 CONCLUSIONS AND RECOMMENDATIONS

The task of water utilities is to serve customers by producing good quality and sustainable water and wastewater services at a competitive price. Increasing service level demands from customers and authorities, ageing utility infrastructures, and knowledge escaping utilities due to retirement call for emergency measures by utilities. The information needs, acquisition channels, knowledge sharing and retention practices of water utility personnel have presumably not been studied earlier in Finland. This research serves as a base for future research on the importance of knowledge management and knowledge retention at water utilities. The key conclusions, scientific contribution and needs for future research are presented in this chapter.

7.1 Conclusions

Today turbulence at water utilities is similar to turbulence in any other organisation. There are several things which pose challenges to water utilities, for example, technological developments both in processes and analysing equipment, new legislative decrees and acts, more stringent environmental permits, demanding customers, economic constraints, digitalisation, and ageing personnel. It is especially important at any water utility not to lose the personnel's expertise and knowledge. As a strategic asset, utilities should pay more attention to the utilisation of knowledge they possess and to the long-term development of knowledge strategies.

Information, knowledge, knowledge management and knowledge retention

This dissertation provides evidence for the interpretations of information, information acquisition, knowledge management and tacit knowledge. It is essential for an organisation to know what data, information and knowledge are needed for various tasks and units, and especially where tacit knowledge is hidden. The amount of critical knowledge, i.e. data, information, knowledge or tacit knowledge, critical for the sustainable operation of water utility, is huge. Similarly, the information overload from where the critical knowledge should be traced is vast. This is the first study in Finland that has found the versatile needs and acquisition channels of information that personnel at water utilities need to perform their daily tasks. Channels and formats of information should be offered in the most appropriate way person by person. However, because the use of the internet and intranet has increased remarkably between 2004 and 2013, it is anticipated that electronic form will be the dominating format in the future.

A special knowledge management and development strategy is needed, because quality management systems alone do not solve the challenges of knowledge retention. Effective communication media, including technological solutions and knowledge management programmes,

like the water and wastewater network information system, should be fully utilised. In addition, information and knowledge sharing structures and media should be planned and implemented to meet the various needs and capabilities of different personnel groups.

Tacit knowledge should nowadays be rooted in knowledge management systems, and it has to be seen as a part of work management. The tacit knowledge, possessed especially by experienced personnel with a long working history, should be made explicit. Tacit knowledge capture, like knowledge capture in general, can be done along with normal daily tasks, by regular knowledge audits or by exit interviews. The easiest way to transfer tacit knowledge is sharing it with other employees, through, for example, formalised 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. By collecting and analysing stories – especially on customer relations and work procedures – water utilities can gather valuable information, which can be used in developing its services and work methods. In addition to traditional, i.e. face-to-face storytelling, communicating stories can be done digitally and shared on the utility's intranet or other closed platforms, for example.

Utility and personal level networks

At water utilities the role of trade unions and professional associations are not seen as important channels for acquiring new information or knowledge. Most of the personnel are members of trade unions just to have a safeguard for unemployment benefits, while membership in professional associations relates to education identity. At the individual level neither trade unions nor professional associations are used to solve, for example, technical or operational problems faced during the daily tasks. At the utility level over 90 percent (over 300) of the Finnish water utilities, including Pori Water, are members of the Finnish Water Finnish Water Utilities Association (FIWA), which produces information and knowledge on topics related to water utilities, and organises training for various utility personnel groups. Professional networks outside Finland or individual memberships in international associations were not found in this study.

The most important network was that involving one's closest co-workers; solutions to problems related to daily tasks were sought first from this network. The distances between co-workers were short, linking together their teams or units, not reaching outside to other units. When in need, professional help for daily tasks was sought from external networks, which spanned mainly to the city offices and to national contacts in companies or organisations.

However, the role of professional networks should be more heavily emphasised because they carry knowledge and shared experiences that otherwise would be impossible to trace. The local contact networks of the water utility were found to be wide and extensive, but on the national level more contacts should be established with other water utilities.

Organisational development

The mission, vision, and purpose of the water utility have to be made clear to every member of the personnel. That would make it easier to reach common goals, improve quality, and meet future needs. It is quite obvious that water utilities have to cope with a diminishing workforce in the future, too. Technological developments and digitalization will pose other kind of challenges at the water utilities. To cope with the challenges, water utilities need to make strategic decisions. One of the starting points would be to assess the core competencies and qualifications needed for particular tasks. Water utilities should evaluate which core competencies need a permanent employee, which of the competencies could be acquired with further educating current employees, and which activities could be outsourced or produced in co-operation with other organisations. Pori Water should evaluate which basic services their personnel should perform and which activities could be outsourced. Development efforts should target areas that benefit the organisation itself the most.

To foster organisational learning, personnel should be acquainted, at least on a general level, with all the activities the water utility as an organisation engages in. The results of the research indicate that personnel's orientation is limited to their particular unit and task. In fact, there were employees who had never visited the other units. The orientation of new employees, either hired outside the utility or promoted internally, should be blended carefully into the utility. Personal learning is a social activity, which is why the personnel's interest in other units and tasks should be kindled. This would promote development of the whole organisation. Visual web-based occupational instructions and work guidance (including water and wastewater treatment processes flow-charts, animations, etc.) with efficient search possibilities should be created and used together with printed notes. Web-based information distribution will not alone be adequate; mentorships would be effective on-the-job training means. In mentoring, employees with more experiences transfer knowledge to those with less experience.

Organisational culture, sharing atmosphere and innovative environment

The organisational culture is closely related to organisational learning and to how the employees' knowledge and skills are utilised. It also affects the personnel's possibilities to attend further education and continuous training and how committed they are to the organisation. Action should be taken towards establishing a single shared, common culture. That is also necessary to be able to respond to the future demands mentioned at the beginning of this chapter.

The knowledge sharing environment should be open, and there should be enough space and time for creativity. This would remove a major obstacle – not having enough time – that is preventing the dissemination of information and knowledge.

The personnel should feel that their skills and knowledge are valued. They should be made aware that sharing knowledge will benefit both the person and the organisation, and that employees' positions will not be threatened if they share something. Each individual contributes to the

organisational development, change and more efficient working environment. Perhaps reward or other benefit systems should be used for showing appreciation of effective sharing.

Professional training and career development

Water utilities should also try to encourage personnel to rotate between units and tasks within the utility. That would affect the organisation in two ways: it would gain hold of its own resources and make tacit knowledge available to others, which in turn would lead to possibilities to create new knowledge. It would be worth exchanging personnel for a short period with other regional water utilities, too. Possibilities for job rotation and career development in the utility might also keep the personnel motivated and keep them in the organisation. How the millennial generation (born in 1981−1999) change the workplace and how water utilities should respond to that challenge are questions that need to be tackled quite soon.

Formal, professional education gives general qualifications for the tasks, but particular knowledge and skills are learned on-the-job. Professional training, including vocational training and apprenticeship or competition-based tests should be utilised in a systematic way at the utility. On the national level, the vocational qualifications for the Finnish water sector will be an asset that should be seized. The research also shows that bachelor degree holders will find employment in the water utilities. However, their background may be from disciplines other than water and wastewater engineering. Special further education should be offered to them to increase their knowledge of water utilities. Master's level education in water and wastewater engineering should also be redeveloped to meet the needs of digitalisation, knowledge management and more widely, management and institutional issues.

Supplementary education and training courses for water utility personnel should also be seen as investing in the future. It should be emphasised that today's working life is so hectic and turbulent that, in order to survive the competition, lifelong learning of the personnel should be seen as a responsibility of both the employer and the employee. In several seminars it has been said that 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 really is needed and how to best organise events.

Tackling the age structure

The truth, however, is that, at Finnish water utilities the retirement boom will last another 5 to 10 years. It is a critical problem, which should be tackled as soon as possible by employing new, motivated and professionally skilled personnel to work side by side with the experienced, retiring employees. The practical learning period depends on the tasks and could vary from a few weeks to several months, even to almost one year. When talking about ageing of workforce, it has been assumed that millennials have different traits than their predecessors, especially because they have been born in the era of technology. Ageing may also pose generational tensions at water utilities,

and a fundamental question is how to assist older and younger generations in working side by side and learning from each other to reach common goals.

Visibility in media

Water utilities are not considered attractive employers in Finland. They have to compete with other, more attractive professions and organisations. Water utilities are not visible or media trendy, and they only make headlines when something negative or unpleasant occurs, i.e. water supply shortages, outdated distribution network or untreated wastewater discharges. Water utilities should be in newspapers, broadcasts, on the internet, including social media, and should arrange media campaigns regularly to avoid being discreet. The use of social media, contradictory to findings in this dissertation, can be expected to enter into the water utilities in near future. Social media applications are the tools to reach the next generation.

7.2 Scientific contributions

Although knowledge management has long been a part of scientific discussions, the importance of deeply understanding knowledge management has lately gained more strategic importance in organisations. Today organisations need to leverage knowledge to enhance their competitiveness. From this point of view, the situation is similar at water utilities. Developments in information technology and digitalisation have widened possibilities to manage knowledge and improve performance.

As far as it is known, information needs and channels of water utility personnel are largely under-examined both internationally and nationally. Thus, it was very hard to find prior results of research dealing with information needs and channels at water utilities. In Finland this dissertation has been one of the first attempts to thoroughly examine the various information needs of the water utility personnel, from the top management to the shop-floor, and the acquisition channels they use when they perform daily tasks.

The results also indicate how the personnel in a water utility interpret information, information acquisition, knowledge management and tacit knowledge and what type of professional networks exist in a water utility. The existence of critical and tacit knowledge and means of knowledge retention at water utilities have been covered in this study. Water utilities may use the findings in the development of knowledge management systems and strategies.

The multiple sources of evidence were gathered from experts at other water utilities and organisations closely involved in water sector regulation and control activities. Empirical findings from tacit knowledge, knowledge capturing and sharing, professional networks and knowledge retention at water utilities contributed to the understanding of the importance of knowledge

management. The results also indicate the importance of knowledge management towards better performance at water utilities. At water utilities, knowledge is about making good decisions and taking the best actions in particular situations.

A limitation of this research is that it deals thoroughly with one water utility only. However, the gained results are supported with the evidence from multiple water utilities and water sector organisations. The most important scientific contribution of this dissertation is that knowledge management was explored comprehensively in a sector that has not been studied extensively earlier. The results contribute to the body of scholarly literature in information and knowledge acquiring, creation, sharing and retention of water utilities. Thus, the empirical findings will be of use to information, business and engineering science communities.

7.3 Recommendations for further research

This dissertation raised many questions in need of further research. Nowadays water utilities likely operate in a more complex and challenging environment than ever before, and they have to cope with requirements posed by technological developments, financial constraints, an ageing infrastructure, ageing personnel, a diminishing workforce, operational efficiency, resilience and sustainability, etc. It is recommended that further research be undertaken in the following areas:

I. Information and knowledge management in different sizes and ownership water utilities

This research only deals only one water utility. It does not address the differences in information and knowledge needs, acquisition, sharing and retention of personnel groups in other water utilities. A more in-depth study is needed to find out how information and knowledge needs, acquisition channels, knowledge sharing and knowledge retention differ at water utilities of different sizes and what effect ownership – municipality-owned, co-operative, private, or public-private partnership – has on them. Special emphasis should be placed on knowledge gaps in utilities: are the gaps in engineering, skills, technical expertise or somewhere else? Further study is also needed on utilities' knowledge and operation management applications, strategies and tools.

II. Professional networks and communities

Networks and communities are very interesting phenomena in the water sector. There is a real need to determine the characteristic of networks, and how their classification into type-based (functional, organisational, technical, economic, etc.), scope-based (local, regional, national, international, etc.), feature-based (positions, processes, structures, relationships, etc.), and unit-based (people, departments, companies, multinationals, etc.) can be applied to water sector networks. A deeper analysis should be performed on the roles of key persons in networks and communities. The benefits

of the various networks and communities, and the values that water professionals emphasise in those networks, should be studied more closely, too.

Over the years, water-related professional networks and communities have been developed by many organisations and associations. However, their effectiveness in sharing knowledge, developing new knowledge and facilitating more formal organizational learning still needs to be addressed in research. Further research in this area could address the role of tacit knowledge in networks and communities and explore relative questions. One special research topic concerning external networks could be how trade unions and professional associations can have more influence on improving the performance at water utilities.

III. National and international co-operation in research and development

Water utilities should actively create national and international partnerships to ensure finance for research and development in the water sector. Strong partnerships, coalitions of water utilities, companies and educational institutions have good chances to create successful applications and receive funding for developing water innovations. Water utilities could more widely utilise the sophisticated water and wastewater expertise internationally, too. Water utilities should address the challenges caused by climate change and globalisation. Future studies should address the pros and cons of utilities participating in national and international research and development activities. Professional literature, i.e. books, conference papers, journals and research reports, disseminate effectively knowledge on ongoing development work. Thus, there is a need to study the availability, utilisation and impact of this valuable material at water utilities.

IV. Competencies and skills

The fourth research need involves the core competencies and skills needed by employees at water utilities. Technological developments, for example towards smarter water systems, in data collection, analysis and transmission, the Internet of Things and automation technology, are likely to create a need for intensive training programmes. The utilisation of vocational qualifications training is a necessity to ensure a sufficiency of professional persons who will provide water and wastewater services in future. More broadly, research is also needed regarding the development of the curricula of water and wastewater in higher education.

V. Demographic changes at water utilities

More research is required focusing on the demographic changes at water utilities. It would be interesting to assess the effect of new generations on the way water utilities operate in the future. What means are in use or should be created to integrate young, millennial newcomers and seniors with much experience, so that they can work together to benefit the water utility and the whole society in the best way possible?

VI. Public relations and image of water utilities

The task of water utilities is to keep customers satisfied with offered services. Utilities' management should know what kind of information and knowledge customers, either industrial or private, expect to receive and through which channels. Further assessment is needed regarding the mechanisms used by customers to voice complaints on the quality of services or other conflicts. Water utilities should increase their visibility in society; currently, they only draw attention when there are problems, like water interruptions. The role of webpages and social media applications as information channels between water utilities and citizens, customers and mass media should be studied. Research is needed on the public relations of water utilities and their image in regards to their attractiveness to potential new workers, and a study is needed to understand the reasons why water utilities do not attract job seekers.

While the needs for further studies at water utilities are extensive, they are not unattainable. Municipalities and government organisations should also strive for allocating funding and resources for research and development in the water industry, since water services are vital to the whole society. The key stakeholders should work together to maintain sustainable water services. Educators should ensure that the personnel at water utilities have chances to attend further training and receive knowledge of the latest technological developments to ensure resilient water supply and wastewater treatment. The question of the provision of sustainable water services concerns all of us.

I will conclude this study with a quote by the seventh Secretary-General of the United Nations (1997 – 2006) Kofi Annan:

> *Knowledge is power.*
>
> *Information is liberating.*
>
> *Education is the premise of progress,*
>
> *in every society, in every family.*

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ANNEX 1

QUESTIONNAIRE 2004 AND 2013 / PERSONNEL OF PORI WATER

Date of interview __/__/____

1. Person
2. Year of birth
3. Degree, highest
4. Year degree was awarded
5. Educational background

   Vocational / College / Polytechnic / University / No formal professional education
6. Occupation
7. Supervisor
8. Describe your duties
9. Since when have you been working at Pori Water (incl. wastewater unit in the City of Pori)
10. Do you have internet connection at work? *Yes/No*
11. Do you have a PC at work? *Yes/No*
12. Do you use a shared PC at work? *Yes/No*
13. Is there a library (organised collection of documents) at Pori Water? *Yes/No/Do not know*
14. Are there information services available at Pori Water? *Yes/No/Do not know*
15. How often do you use the library or its services?

    1=never, 2=a couple of times per year, 3=once per month, 4=a couple of times per month, 5=once per week, 6=a couple of times per week, 7=daily

16. If there is no library (organised document collection) or the collection is limited, should there be one or should the existing one be better? *Yes/No/Difficult to say*

17. What kind of information do you need in your daily work? (Specify)

    a. *Decisions of Pori Water*

    b. *Terms and conditions of employment*

    c. *Terms of purchase*

    d. *Legislation*

    e. *Technical information on equipment*

    f. *Other information, which kind?*

18. When you need information in your work, how often do you use the following?

    1=never, 2=a couple of times per year, 3=once per month, 4=a couple of times per month, 5=once per week, 6=a couple of times per week, 7=daily

    a. *Personal files/collections*

    b. *Library/document collection of Pori Water*

    c. *Local libraries*

    d. *Discussions with closest co-workers*

    e. *Discussions with other staff members at Pori Water*

    f. *Discussions with personnel of other water utilities*

    g. *Discussions with other experts outside of Pori Water*

    h. *Technical journals*

    i. *Professional books*

    j. *Pori Water internal reports*

    k. *External reports (outside of Pori Water)*

    l. *Conference and seminar papers*

    m. *Equipment manuals and brochures*

    n. *Pori Water notices/bulletins*

    o. *Intranet of the City of Pori*

p. *Internet*

q. *Standards*

r. *Patents*

s. *Electronic databases*

t. *Chat channels, discussion forums*

u. *Others, which?*

19. To what extent would the following means increase knowledge at Pori Water?

1= very well, 2=well, 3=difficult to say, 4=some, 5=little, 6=very little, 7=no effect

a. *Engaging new, qualified staff*

b. *Ordering services from consultants*

c. *Contacts with manufacturers and service providers*

d. *Equipment purchases*

e. *Participation in conferences, seminars, exhibitions, fairs*

f. *Publications and journals*

g. *Computer programs and licences*

h. *Research and development*

i. *Staff training*

j. *Customer interviews/questionnaires*

k. *Benchmarking against other water utilities*

l. *Others, which?*

20. How often do you participate in further education or training events?

In Finland (excluding Pori Water's events), Pori Water's events, abroad

21. Trade union and professional association membership in Finland

22. Professional association membership abroad

23. Whom do you contact at Pori Water if you have problems at work?

24. How do you make contact: *by telephone, by e-mail, face-to-face, some other way, which?*

25. Are these the same people to whom you present new ideas? *Yes/No/Partly*

26. Whom do you contact outside Pori Water if you need professional information? (who and from which organisations)

27. What is your definition for the following terms

    a. *tacit knowledge*

    b. *information*

    c. *knowledge management*

    d. *information acquisition*

    e. *Social media (only in 2013 interviews)*

28. How is tacit knowledge shared with new staff members or with other staff members at Pori Water? By what means can it be ensured that tacit knowledge will not be lost?

29. Do you tell stories to other workers? In what situations?

30. Have these stories been recorded? Is there a need to record them? *Yes/No/Difficult to say*

31. Would you like to tell a story?

32. Have Pori Water projects been reported (in written form)?

    Yes/No/Difficult to say/Some reports have been done

    Do staff have access to them? *Yes/No/Difficult to say*

    Where and in which format do they exist?

33. How are the staff's skills and knowledge utilised at Pori Water?

    1= very well, 2=well, 3=difficult to say, 4=some, 5=little, 6=very little, 7=not at all

34. What are Pori Water's staff needs for the near future (what kinds of skills and/or staff are needed)?

35. What are the workplace orientation practices at Pori Water? (asked of the newcomers only in the 2013 interviews)

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ISBN 978-952-15-3954-1
ISSN 1459-2045