Research & Theory

Importance of Knowledge Management at Water Utilities

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Abstract

Water utilities face continuous challenges with the changes of operational environment, aging personnel, and related tacit knowledge of employees. This article explores knowledge management at one Finnish utility and points out knowledge sharing in daily tasks. It highlights how employees interpret knowledge and tacit knowledge and their sharing. Qualitative inquiry was used. Semistructured interviews were conducted with 61 employees (65% of personnel) in 2004 and 33 in 2013 (47%). Knowledge management was regarded as a personal, individually controlled property. Value was one obstacle to the unwillingness to share knowledge and tacit knowledge. Positive change between 2004 and 2013 was seen in the interpretation of tacit knowledge: being something that is recorded in your own head only. Tacit knowledge was daily shared with the closest coworkers. As a strategic asset, knowledge should be managed at water and wastewater utilities as further development needs crucial understanding of previous procedures and practices.

Keywords

tacit knowledge, knowledge sharing, water utility, constraints, Finland

Introduction

Knowledge Management (KM) and Tacit Knowledge

As KM is a critical success factor for water utilities when striving for better and more sustainable performance, utilities should manage their knowledge assets. KM consists of two main concepts, the recorded and stored explicit knowledge and the tacit knowledge found in employees' heads. Both should be managed as a valuable resource (Probst, Raub, & Romhardt, 2000), and together they form an organization's collective

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expertise (Awad & Ghaziri, 2004). KM consists of three overlapping components: people, technology, and organizational processes (Awad & Ghaziri, 2004; Bennet & Bennet, 2011; Grigg & Zenzen, 2009; Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee, 2011). Value creation may be achieved by capturing, storing, creating, applying, and sharing knowledge among personnel, customers, and stakeholders (American Productivity and Quality Center [APQC], 2016; World Bank, 2011, 2015). Knowledge resources development is an ongoing activity, which should start from the premise of what organizations know and what knowledge deficits are there, and how they manage knowledge resources with technology-driven solutions (Heath, 2003).

Basic definitions and approaches of KM also apply to water utilities as they conduct their tasks according to business principles. However, there is a relative paucity of empirical research focusing specifically on KM and tacit knowledge at water utilities. KM at water utilities is linked to organizational knowledge (Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee, 2011; Price, 2001), which supports learning in organizations (Bennet & Bennet, 2011; Grigg & Zenzen, 2009). In business strategy, organizational knowledge includes identifying key knowledge, as well as capturing, storing, retrieving, and sharing of it (Bennet & Bennet, 2011; Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee, 2011; Price, 2001). The role of water utilities and their employees, public officials, citizens, and policy-makers in the KM of the water sector should also be addressed because responsible policy-level decision making relies on evidence-based knowledge (Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee, 2011).

Water utility employees are the key actors in different phases on KM as they utilize information, knowledge, experiences, and skills in their day-to-day work, that is, doing things right and doing right the things (Bennet & Bennet, 2011; Grigg, 2006; Water Research Foundation, 2011). Water utilities have significant underground and structural assets, of which they do not have enough knowledge. As Price (2001) points out, this is alarming because utilities' ability to provide good services to customers economically depends on proper utilization and maintenance of all assets.

Whereas explicit knowledge is tangible and rather easy to manage, intangible tacit knowledge is a challenge for any organization. It is the most valuable asset an organization possesses as sustainability can only be developed by capturing and transferring tacit knowledge (Lubit, 2001). Tacit knowledge is internalized in organizations; embedded in the company culture and their people, routines, and processes; and is thus not easily available. Individuality is a common feature in the various definitions of tacit knowledge. Tacit knowledge is obtained by work activities and intuitions (Choo, 1998) and by experience and reflection (Haldin-Herrgard, 2000) and is equated with feelings and know-how about a particular topic (Brooking, 1996; Ståhle & Grönroos, 2000). Every employer can recognize the explicit knowledge people possess, but they cannot see the missing links or intuition-based elements, that is, tacit knowledge (Haldin-Herrgard, 2000). In fact, a person may not even be aware of this tacit knowledge until faced with a specific situation or problem (Blankenship, Brueck, Rettie, O'Berry, & Lee, 2008; Hasanali, Haytmanek, Leavitt, Lemons, & Newhouse, 2003; Wolfe, 2009).

Tacit knowledge which makes up for 95% of all knowledge can only be transferred from one person to another by doing together and talking (Ståhle & Grönroos, 2000). Some people can easily articulate contents, whereas for others, it is hard to externalize (Dalkir, 2011). This means that the same content can be explicit for one person and tacit for another. Because tacit is hiding in routines and behavior, it is difficult to observe or measure (Boiral, 2002). Tacit knowledge normally means knowledge in people's heads, and that extracted, codified, and communicated tacit knowledge turns into explicit knowledge (Allee, 2003), although repositories only show who has the critical knowledge and experience (Blankenship et al., 2008).

According to Geldof, van der Heijden, Cat, and Valkman (2011) and Heath (2003), managing of tacit knowledge differs between experienced experts and novices. Skilled and experienced experts have difficulties in articulating their know-how, whereas novices can explain what they do because they follow manuals or how-to processes (Dalkir, 2011). Novices may not directly need the knowledge of more experienced employees, but they have to figure out tacit knowledge, that is, what experts think and feel, how they respond and react (Heath, 2003).

Knowledge, whether explicit or tacit, is important for personnel in performing the given tasks. Operating information contains a significant amount of tacit knowledge, subject to be lost when an employee leaves a company. Therefore operational information and tacit knowledge needs to be updated by capturing knowledge and making knowledge available (Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee, 2011).

Challenges in Sharing Knowledge

It is not, however, enough that organizations have knowledge. To be able to satisfy an organization'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). Emphasis has to be on the quality of knowledge and the timing and place of sharing it. The sharing of knowledge is important also concerning the gray literature, that is, written reports, manuals, working papers, and so on which do not enter into databases or other depository systems and are thus not easily accessible (Price, 2001).

Stories, storytelling, narratives, gossip, myths, tales, and so on have been used in organizations since their existence. In any organization, there are stories that spread throughout the organization and even beyond it. Stories have several roles and tasks in organizations: some highlight past events and cultures, some build institutional memory, and some are just gossip (Cohen & Prusak, 2001; Cowan, 2014; Davenport & Prusak, 2000; Liebowitz, 2009; Snowden, 2003). In fact, stories and narratives are nowadays a significant factor in organizations and companies because they provide a practical way for sharing knowledge.

Knowledge sharing needs organizational and technical infrastructure, but these only constitute a part of the sharing environment. Infrastructure combined with individual and cultural issues form the basis for knowledge sharing. There are several possible organizational, cultural, or individual reasons why knowledge is not necessarily shared in organizations, as shown in Table 1.

Table 1. Constraints in Sharing Knowledge.

Organizational characteristics and barriers	Individual characteristics and barriers	Cultural characteristics and barriers
Hierarchical structures	Individual's personality, talents, and social behavior	Organizational culture
Functional structures	Willingness to share	Power distance
Organizational 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 (including wiki, mobile devices, video technology)	Lack of ability to use communication channels and social media applications	Vocational reinforcers: compensation, recognition, ability utilization, 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

Source. Awad and Ghaziri (2004); Baker et al. (2004); Bennet and Bennet (2011); Blankenship et al. (2008); Boiral (2002); Dalkir (2011); Davenport and Prusak (2000); Devlin (1999); European Committee for Standardization (CEN; 2004); Haldin-Herrgard (2000); International Water and Sanitation Centre (IRC; 2004); Knowledge Management Subcommittee of the AWWA Workforce Strategies Committee (2011); Leonard et al. (2015); Liebowitz (2009, 2012); Lubit (2001); Probst et al. (2000); Visscher et al. (2006); and Wilson (2009).

Management and leadership play an important role in knowledge sharing. If the 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 utilize modern KM tools and understand the importance of knowledge sharing. Leadership, support from management, leading by example, and integrating personnel in knowledge projects are critical factors in motivating personnel to share information and knowledge (Bennet & Bennet, 2011). Long-term, positive experiences are needed to build trust (Probst et al., 2000), but gained trust is easily lost due to negative events. If the hierarchical and functional barriers conflict with each other, the result might be a splintery organizational knowledge base (Probst et al., 2000), that is, in organizations with several departments and teams, knowledge is shared within the staff's closest desks, but not necessarily between other divisions (Visscher, Pels, Markowski, & de Graaf, 2006).

Daily tasks are often carried out under hectic and turbulent conditions, leading to information overload. 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. The more experiences the personnel has, and the more tacit knowledge is rooted into the practices, the harder it is to dig it out from the employees' heads. Sometimes people are not conscious of how much they really tacitly know. Therefore, tacit knowledge remains elusive (Bennet & Bennet, 2011; CEN, 2004; Haldin-Herrgard, 2000; Probst et al., 2000).

Time is the most significant obstacle to sharing critical, experience-based knowledge (Leonard, Swap, & Barton, 2015). Other significant obstacles include experts who are reluctant to share, unwillingness of younger employees to learn from senior workers, and generational differences. The knowledge gap between younger and older employees may be too wide if the newcomer lacks foundational knowledge and does not appreciate the experience (Leonard et al., 2015). If the differences between generations and personalities (Grigg & Zenzen, 2009; Hurley, Laucamp, Rehg, & Robinson, 2007) 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. Critical success of knowledge flows depends on shared values, reciprocity, intrinsic worth of knowledge, convenient transfer mechanisms, interpersonal trust, and respect (Liebowitz, 2012). Every generation should cooperate, tolerate, and accept the other generations and recognize other generations' preferences, communication styles, work schedules, and so on (Wilson, 2009).

Willingness to share knowledge depends on many factors. Some of them are related to the employees' attitudes about sharing, and some to the pride in the ownership of one's expert knowledge. Quite often employees fear that if they share their knowledge with others, their own position in the organization will be endangered (Haldin-Herrgard, 2000; Liebowitz, 2009; Probst et al., 2000; Visscher et al., 2006). When employees are valued (Awad & Ghaziri, 2004) and they feel secure in their own position (Bennet & Bennet, 2011), they are more willing to share knowledge.

Water organizations tend to use solutions that rely on traditional working practices (Price, 2001) and seem to have negative attitude toward technology, rationalization, reorganization, increasing scale, and so on (Geldof et al., 2011). Explicit knowledge in these solutions is found in protocols, procedures, planning and control routines, expert systems, and so on, but they fail to capture tacit knowledge. KM technology is important in the securement of performance in a water utility, but financial constraints and lack of user-friendliness of the systems hinder implementation of KM projects at water utilities (Bennet & Bennet, 2011).

Knowledge may disappear due to an employee's retirement, transfer to another organization, acute or chronic disease, or death. When an organization loses an employee, it also loses part of its organizational memory (Brooking, 1996). Organizational memory is decentralized and consists of independent memories that can die and desert the critical mass at any time. 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).

Special Features of Finnish Water Utilities

The special characteristics of Finnish water services are related to political, economic, socio-cultural, technical, environmental/ecological, and legal aspects (Pietilä, Katko, & Seppälä, 2010). In Finland, water services are monopoly services, where utilities are typically owned by municipalities and administratively under the politically elected board. Citizens are accustomed to pay for water services, water services coverage is close to 100%, and water quality requirements are high. Investments in treatment facilities and networks are covered mostly with water tariffs (Pietilä et al., 2010). Stipulated by the legislation, water utilities have to pay out a certain share based on their revenues and earnings to their owners, although that money may be then allocated for other municipal services. Previously mentioned characteristics are indirectly included also in the mission of the case utility, that is, "to provide water and wastewater services at a competitive price taking into account customers' needs and environmental sustainability." To be able to improve their performance, water utilities have to respond to the customer's water service expectations, financial and regulatory requirements, succession planning, and knowledge transfer needs. Thus, knowledge has to be managed in a systematic and strategic way.

Objectives and Research Questions

Sharing and retention of knowledge is a topical question also at Finnish water utilities, which face a demographic shift when new generations with new skills are being recruited to utilities. If capturing of the huge knowledge base of the retiring baby boomers is neglected, utilities will lose valuable knowledge. The strategic question is how to get the personnel to share their knowledge, especially their tacit knowledge, to ensure knowledge retention and use at water utilities. Although some research has been carried out on knowledge and knowledge retention at water utilities abroad, there is very little scientific understanding of KM and tacit knowledge at Finnish water utilities. The purpose was to fulfill the lack of scientific understanding of knowledge resources and knowledge sharing practices at water utilities. The major research questions are as follows:

> **Research Question 1:** How do personnel at water utilities interpret the concepts of KM and tacit knowledge?
> **Research Question 2:** How is knowledge captured and shared?

Water utilities have to manage information and knowledge assets to achieve their performance goals. After the review on KM and tacit knowledge as well as the challenge of knowledge sharing, we will continue with a study on a case water utility in Finland. The water utility personnel's general interpretations of these are examined in the first research question. Special emphasis is on tacit knowledge, how the personnel understands it, and what types of tacit knowledge exists at water utilities. The second research question tackles knowledge sharing and possible barriers constraining sharing.

Method

The use of qualitative case study was employed as phenomena were studied in the real-world context of a Finnish water utility. This municipally owned company produces both water and wastewater services to domestic and institutional users and some industries, which is a common practice in Finland (Katko, Kurki, Juuti, Rajala, & Seppälä, 2010). The research had two phases, that is, the data gathering at the case water utility relied on semistructured theme interviews in 2004 and in 2013. A questionnaire form was used to save the answers during the interview directly to a computer. The structure of the interviews was not very strict, and it was possible to discuss the various topics in quite a flexible order. The first phase of the field research was carried out at the case water utility, where 61 employees (65% of the total number of personnel) were interviewed from June to October 2004. The second phase of the field research was conducted 9 years later from September to October 2013 at the same water utility, where 33 employees (47% of the total number of personnel) were interviewed. Both individual interview phases included representatives from all personnel groups, and 26 interviewees participated in both phases. Recording was utilized in approximately 30% of the interviews, as many of the interviewees did not approve recording. Yet, this has no effect on the results because answers could be entered on a computer during the interview. The questionnaire focused on the following main areas: how the interviewees interpreted (a) KM and tacit knowledge, (b) stories, and (c) knowledge and tacit knowledge sharing. The semistructured questionnaire contained both structured questions and open-ended questions. Simple statistics were used to show frequency distributions. The open-ended questions were analyzed by coding the information into common subthemes. With the content analysis, the themes were further interpreted to identify core meanings.

Results

The results indicate changes in interpretations of KM toward personal and individual property. In 2004, altogether 38% of the interviewed said that KM means informing the personnel, 29% related KM as a personal property, 23% gave no definition, and 10% associated it with computers and power. In 2013, the definition for KM given by 73% was personal, individual property, 15% connected KM to computers and data management systems, and 12% could not give any definition. In 2013, almost all of the interviewees stressed that KM is individually controlled. The personnel were proud of the technical knowledge they possessed of the water treatment processes which is critical to the success of the utility. Workers utilize their own memory, information, and knowledge in their work; value information related to practical tasks; and are always eager and ready to learn more. In many responses KM related to worker's own performance, that is, how well they carry out given tasks, are they doing the right things, can they manage their knowledge and use it in the right way. They emphasized that water treatment processes are complicated and that one should understand what is really happening in the process, not just turn the button routinely. Still, respondents valued the knowledge they possessed so much that some of them were unwilling to share it as knowledge is a means of securing one's job.

In 2004, organizational KM was linked to individual tacit knowledge and information given to customers. Leadership and sharing were new dimensions in the 2013 answers, and the meaning of organizational knowledge to the whole organization was clearly understood. System information was the kind of information stored in computers, databases, or other media. It included all the water and sewer network information, digital maps, decisions made by the water utility, books, especially product catalogs and online instruction manuals, and so on. Although the responses in 2013 emphasized stored information as belonging to KM, the utility network information system design application was used only in recording the network data, and not seen as a KM tool.

In 2004, tacit knowledge was an unknown concept as 47% of the interviewees had either never heard of the term or could not define it, and 23% thought tacit means that you keep quiet and say nothing even if you know something. In 2013, the tacit concept was quite clear to most of the personnel, that is, 82% could explain the concept. This positive change can be explained by the fact that between the study periods, the concept of tacit knowledge had been discussed in various media, linked with the retirement boom and tacit knowledge disappearing with those retiring.

Work experience–based tacit knowledge is knowledge that workers have gathered over several years from doing the same tasks. The basis for craftsmanship-related tacit knowledge was laid in professional training, although the informal, hands-on training during daily work was valued more. Workers know on the basis of their previous tasks, and from their working experience, how they should handle the tasks they are given. Experiences, trials, and errors have developed into tacit knowledge, which is personal, and shared only if someone is clever enough to ask for it. The value of work-based tacit knowledge was considered high and somehow regarded as being much better than other knowledge. Workers work instinctively to some extent, and as one of them said, they could do their work with eyes closed. Their work involved some routine phases and the procedures had been developed over the years. Workers share tacit knowledge with their closest coworkers, and there is always someone more experienced who can give advice on the tasks. Tacit knowledge was associated, for example, with the following:

- Equipment and structures:
  - Noises that pumps make: An experienced employee can tell from the noise whether a pump is working properly or whether there is a problem with it.
  - Noises from structures: An experienced employee can tell from the noise whether there is a problem or what kind of possible problem exists.
- Process performance:
  - A certain type of a smell of the wastewater process indicates process failure.
  - Color and structure of activated sludge indicates how the process works.
  - Color of the foam indicates pH value.
- Networks:
  - All network data are not available on maps, and information should be drawn from employees or through site observation.
  - Valves and their location in buildings: Several valves have special features known only to those working in the area.

Usually tacit knowledge was understood to be something that is not recorded anywhere else than in your own head. Interviews imply that tacit knowledge is intangible but at the same time transferable to others. That is possible when tacit knowledge is made explicit by working together and learning by doing. Interviews in both years indicated that tacit means keeping quiet about matters you know and not documenting or sharing information you have. Envy as a reason for not sharing knowledge came up in the responses leading to situations where employees did not all have the same opportunities to get information or to be informed.

There are many ways to share information and knowledge and a number of reasons were found explaining why this was considered difficult. Interviews in 2004 and 2013 indicated that knowledge and tacit knowledge was being shared mainly through daily tasks. The employees highly valued the professional skills and knowledge of employees with a long working history. Knowledge and tacit knowledge sharing took place at the actual work site where problems arose, and 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 coworkers. Especially tacit knowledge was shared automatically during everyday work. There were established practices when it came to how tasks were performed. The documentation of, for example, pipeline repairs also followed a fixed format. It is crucial for employees to understand how past events and practices have shaped current situations, while work procedures should be developed further.

Knowledge sharing happened between coworkers, and between newcomers and those with a long working history. Some of them had been working with the same team, person or persons for more than 10 years, some even 20 years. Knowledge is shared, for example, during shift changes, when operators tell about the state of the process or, after the weekend, when the customer service desk receives information about burst pipes or other encountered problems. The role of coworkers was identified also when a successor to a retiring employee is chosen; the retiree will transfer the valuable knowledge to the new position holder. Sometimes, a person hired from outside the utility or via municipal merges may transfer useful information to the new employee, for example, information of networks, pipe materials, valves, fittings, and so on. 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, regarding 50-year-old undocumented pipes.

In 2004, knowledge was largely shared in personal discussions and during breaks. Interestingly, the 2013 interviewees indicated that coffee table discussions had partly lost their relevance in 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. 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 as the personnel preferred to hear things face to face. In 2013, computers were seen as an additional way to acquire information.

In 2004, KM software was seen either as a helpful tool for storing data and information or as "technical nonsense." At that time, use of the water and wastewater network information system design application was said to be in its initial stage. It was seen as having something to offer in network management and maintenance operations as IT-based systems could be a great tool in delivering network information to future generations. In 2004, network leakages were repaired without recording how and where they were repaired, although the application made it possible to document the network condition and determine the network renovations needs. By 2013, the application usage was improved, and it served the purpose of storing and transferring knowledge across generations.

Stories contain both tacit and explicit knowledge, and they also reflect attitudes. The collected 35 stories mainly dealt with work procedures, events, former and present employees, customer relations, and rumors. The role of stories was seen as 2-fold: Some thought that stories were only meant to be amusing, whereas others viewed them as educational. In 2013, stories were not told to the extent they were told earlier, which is the consequence of retired storytellers, increasingly straining workload, and decreased possibilities for spreading of stories.

In both interviews, many of the interviewees mentioned the question of the generation gap between younger and older employees, and the lack of mutual understanding. The inability of older employees to absorb new knowledge quickly enough may irritate the younger ones, whereas the know-it-all attitude of the young can irritate 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 behavior is explained by older employees' reluctance to guide the younger ones. However, 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.

Both in 2004 and in 2013, tacit knowledge was shared as well as concealed. Some said that they actively shared any information and knowledge they had, whereas others emphasized that sharing depends partly on the receiver who should be active and brave enough to ask questions. Some were not willing to share knowledge at all.

Difficulties in sharing tacit knowledge were revealed indirectly by the interviewees both in 2004 and 2013. Personnel, from top to bottom, were concerned about the aging of personnel and related knowledge disappearing the day they will retire or otherwise leave the utility. One of the main reasons why tacit knowledge sharing was insufficient was the small number of new employment contracts, meaning that no transferred knowledge receivers were available. The results of the interviews in 2004 and 2013 indicated several reasons why sharing of knowledge is difficult. These can be summarized as shown in Table 2.

Discussion

With respect to the first research question on KM and tacit knowledge, it was found that KM interpretation at the case water utility had changed between the study years.

Table 2. Synthesized Constraints in Sharing Knowledge at the Water Utility Based on Interviews in 2004 and 2013.

Organizational characteristics and barriers	Individual characteristics and barriers	Cultural characteristics and barriers
Hierarchical structures: management structure does not favor sharing	Individual's personality, talents, and social behavior: personal characteristics and inactivity, people do not seek knowledge actively	Organizational culture: N/A
Functional structures: 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	Willingness to share: unwillingness to share	Power distance: N/A
Organizational strategies, initiatives, and policies: N/A	Resistance to change: N/A	Value of knowledge: employees prefer to keep knowledge as their private property
Management and leadership practices: internal information flow incomplete, supervisors do not get information, for example, of problems occurring with equipment	Attitude: negative attitude toward sharing	Atmosphere of trust and respects: N/A
Financial constraints: N/A	Lack of training: no master–apprentice system	Language: N/A
Lack of up-to-date information: network maps partly out of date, older employees have knowledge which is not documented or shared	Perception (personal knowledge): N/A	Work norms: N/A
Convenient knowledge management infrastructures, new technologies, and devices (including wiki, mobile devices, video technology): N/A	Lack of ability to use communication channels and social media applications: N/A	Vocational reinforcers: compensation, recognition, ability utilization, creativity, good work environment, autonomy, job security, moral values, advancement, variety, achievement, independence, social status: N/A
Manpower and knowledge drain; workers leaving the company; high retirement rate, distorted age structure, mean age close to 50 years; no new personnel, no one to share knowledge with	Lack of time due to work burden	Different generations: gap between older and younger generations—do not speak the same language

Note. N/A indicates that characteristics and barriers did not apply to this case.

In 2004, the personal property interpretation was predominant for more than one third of the interviewees, whereas in 2013, their share was already more than two thirds. Long work experience at the same positions with the same coworkers, and diminishing workforce which creates stress and fear of losing jobs, were key features explaining the change in KM. Personal property reflects engagement in the task-related knowledge ownership as a powerful means to safeguard one's job. Both in 2004 and 2013, the interpretations for tacit knowledge highlighted the work-based, "learning by doing together" experience and craftsmanship-based knowledge gathered over the years. The good understanding of the concept of tacit knowledge in 2013 was associated with extensive media coverage on tacit knowledge, retirement boom, and tacit knowledge disappearance with the retiring personnel.

This study is in line with the literature findings pointing out that different forms of knowledge exist at the utility: Explicit knowledge existed in various formalized and codified forms, and implicit knowledge in operating procedures and corporate culture. At water utilities, the daily work is characterized by routines and embedded knowledge of treatment processes, water and sewer networks, products, manufacturers, and customers. One surprising phenomenon was that in 2013 personnel still mentioned lack of technical data or information. Missing or incomplete mapping data from merged water and wastewater systems might explain this finding.

An expected result was that tacit knowledge was associated with process noises, smells, colors, information on underground structures, equipment and systems, information on customers and contractors, and so on. This kind of tacit knowledge is valuable for the utility and should be made visible, so that operation and maintenance practices could be developed more effectively. In communication, especially between coworkers or teams, voice, facial expressions, body language, emotions, and so on transmitted much tacit knowledge.

The second question in this study sought to determine knowledge capturing and sharing. A rather unexpected result was that in 2004, the most powerful ways to share information and knowledge were informal coffee break discussions and other face-to-face contacts which had partly lost their importance in 2013. Although storytelling enables transfer of organizational knowledge, practices, and history, one unanticipated finding was that the role of stories had diminished. These results may be explained by the development of other sharing channels, such as computerized applications and formal meetings. Diminished workforce and hectic pace of work are other possible explanations. Knowledge capture and sharing took place mainly within a team consisting of the closest coworkers, and sharing knowledge outside that team was seen as insufficient. For the utility, this means that good practices do not necessarily spread beyond team or unit boundaries, indicating need for a more positive sharing culture and atmosphere.

The results verify that the processes of exchanging knowledge face several barriers related to organizations, individuals, or cultures. Lack of up-to-date information on water and wastewater systems, nonexistent strategy for managing knowledge, and unwillingness to share knowledge were among the most important concerns at water utilities. One of the most important factors hindering tacit knowledge sharing was the aging personnel at the utility. This really is a challenge and calls for prompt measures.

Tacit knowledge, especially that possessed by experienced personnel with a long working history, should be made explicit and rooted in KM systems. In fact, every employee should have a duty and an obligation to record any important practicality of their work. Cultural characteristics and barriers were not regarded as significant challenges, except for different generations and their ability to "speak the same language." Organizational culture, power distance, and trust were not seen as barriers mainly because of the close and small work community, where coworkers know each other since years ago, share similar work norms, and the same mother tongue.

Today, turbulence at water utilities is similar to turbulence in any other organization. There are several things which pose challenges to water utilities, for example, technological developments both in processes and analyzing equipment, new legislative decrees and acts, more stringent environmental permits, demanding customers, economic constraints, digitalization, and aging personnel. It is especially important at any water utility not to lose the personnel's expertise and knowledge.

The qualitative approach used in this study, with two data collection phases over 9 years, worked quite well although the longitudinal method is not commonly used in engineering sciences. The ethical principles and autonomy of employees were respected, and the validity of the results reflects the reality and understanding of the utility personnel. The research focused on only one water utility, which is a limitation. However, the results contribute to scientific understanding of complex and challenging KM environment in the water sector. There is still a lot to be done for promoting the importance of KM at water utilities, and further studies on KM in water utilities of different size, type of ownership, and the effect of demographic changes on the operation of utilities are needed.

Concluding Remarks

This study set out to gain understanding of the interpretations of KM and tacit knowledge and sharing activities of Finnish water utility personnel. The results showed how personnel valued all types of knowledge, explicit, implicit, and tacit, and how huge the amount of critical knowledge really is for the sustainable operation of water utility.

Water utilities should pay more attention to what kind of knowledge is needed for various tasks and units, and especially where tacit knowledge is hidden. A special KM and development strategy is needed at water utilities because quality management systems alone do not solve the challenges of knowledge retention. Strategy formulation relies not only on knowledge base but also understanding how different types of knowledge are communicated and most effectively stored in various systems for utilization in day-to-day operations. It is self-evident that electronic form will be the dominating format in the future. Effective communication media, including technological solutions, like the water and wastewater network information system, should be fully utilized. 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 capture, like knowledge capture in general, can be done along with the 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, formalized mentoring or master–apprentice systems, storing it in documents and manuals, making videotapes or taking digital photos of pipeline construction and renovation sites, equipment and treatment processes, or employing external interviewers. By collecting and analyzing 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, that is, face-to-face storytelling, communicating stories can be done digitally and shared on the utility's intranet or other closed platforms, for example.

Declaration of Conflicting Interests

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