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Knowledge Reuse in a Small Company in the Water Treatment Industry: A Case Study

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Abstract. This paper presents a case study that explores how a small company in the water treatment industry can facilitate knowledge reuse. Small companies often find themselves focusing resources on operational activities and fire-fighting, preventing them from properly utilizing previously acquired knowledge in new similar projects.

We conducted in-depth interviews with company employees to establish a set of requirements for the new knowledge system. We then gathered theory through a literature review and developed the system iteratively with frequent feedback from employees at the company. The paper includes a case study on an ongoing wastewater treatment plant project in the company.

The new knowledge management system is built up of interconnected A3s that provide the user with both a system overview and detailed information. We validated the results through a survey. The survey displayed that employees were positive towards implementing and using the new knowledge management system. We observed that employees were curious during the development process and willingly contributed when required. This paper also presents different barriers and benefits related to knowledge management initiatives in a small company.

Introduction

Domain. This research paper is based on a company operating in the Norwegian water treatment industry. The water treatment industry provides the population with treated drinking water while collecting the produced wastewater. The complete water treatment system is divided into drinking water sub-systems and wastewater sub-systems. The drinking water sub-system consists of water sources, drinking water treatment plants, pumping stations for drinking water and drinking water distribution systems. The wastewater sub-system consists of wastewater transportation systems, pumping stations for wastewater, wastewater treatment plants and recipients. The overall architecture of the water treatment system is illustrated in Figure 1, where the drinking water sub-systems are colored blue and the wastewater sub-systems are colored brown.

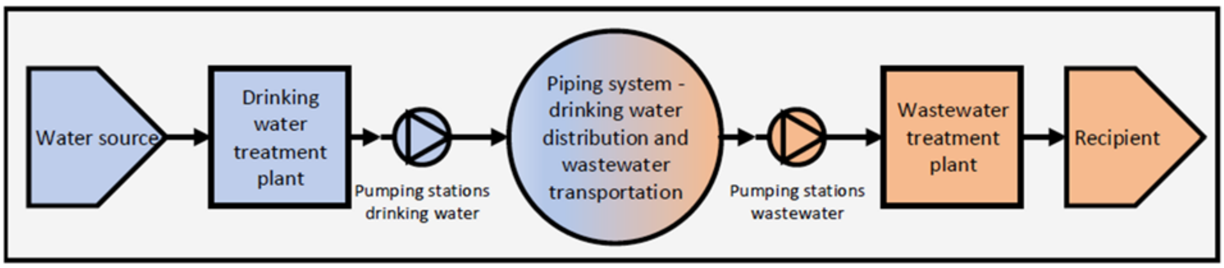

Figure 1: Overall architecture of the water treatment system

The industry is traditional, and suppliers are mostly well-established companies. The Norwegian Ministry of Climate and Environment has issued an action plan that aims to stop the use and emission of environmental toxins by year 2020 (Ministry of Climate and Environment 2015). This will require companies to develop water treatment systems with increased capabilities. The Norwegian municipal water treatment segment suffers from severe backlog. Norsk Vann BA, a Norwegian interest organization representing the industry, released a study in 2017. The study states that Norwegian municipalities needs to invest 31 billion USD before year 2040 (Rostad 2017). This report does not include the need of non-municipal costumers, such as holiday house areas and private contractors.

Company. Vinje Industri Miljø AS (VIM) is a supplier of turnkey systems to municipal and private costumers in the water treatment industry. The company was established as a result of increased uncertainty in the petroleum industry, with employees that have previous knowledge in piping, pumps, valves and control systems. VIM has four employees and delivers systems in the eastern, southern and western parts of Norway. Vinje Industri AS, the parent company, provides personnel when the systems are installed.

Background. VIM was subject to a research study carried out in the spring of 2018. The study investigated how a proactive quality approach could improve the system development process to ensure system-effectiveness and -performance. The author claimed that several systems engineering related activities were either skipped or could have been conducted in an improved manner. The author recommended to implement different quality tools to ensure that systems developed had a greater effectiveness by being "right the first time" (Aziz 2018). The paper emphasized that it would be important for the company to learn from their previous mistakes in future projects (Aziz 2018).

Case. The case used in this paper is a medium-sized wastewater treatment plant designed for a municipal customer. The project is ongoing in the company. The plant is intended to reduce the level of organic matter and phosphorus by a using primary and secondary treatment stage. The primary treatment stages rely on a micro strainer to remove heavier solids. The secondary treatment stage is based on a combination of biological and chemical processes in eight sequencing batch reactors. The plant also consists of a subsystem that dewaters sludge generated from internal processes and external wastewater treatment plants. The wastewater treatment plant is illustrated in Figure 2.

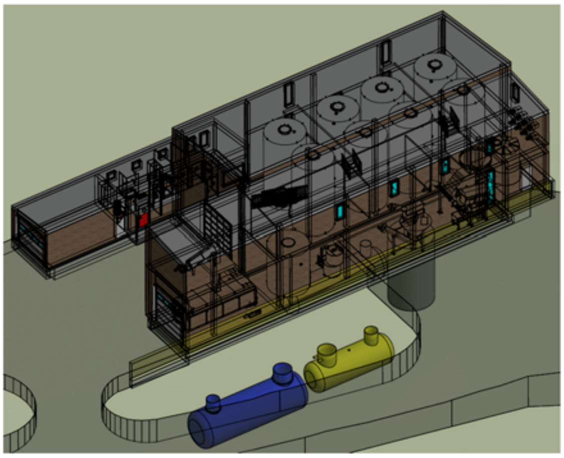

Figure 2: Wastewater treatment plant

Problem statement. VIM has entered a new industry. The lack of essential knowledge has resulted in projects requiring more time and resources than what is used by competitors. The projects are continuous learning processes, and it will be important for the company to implement a system that facilitates reuse of knowledge. Knowledge management theory can be used to retain and reuse valuable company knowledge. The knowledge management system must to be developed by taking into account the small size of the company. Previous research has suggested that information can be communicated efficiently by using A3s. A3s (297x420mm) is a tool used to understandably communicate essential knowledge, using both models and text.

Research questions. These research questions were derived from the problem statement:

1. How can A3s be used to promote knowledge reuse in a small company like Vinje Industri Miljø AS?
2. Which barriers must Vinje Industri Miljø AS overcome to successfully implement a knowledge management system, and what are the main benefits of knowledge management?

Paper structure. This research paper first provides an introduction with information about domain, company, background, case, problem statement and research questions. The next section is research methodology, where we describe the research approach used. We then present the findings from a thorough literature review. The results and analysis chapter provide the case study and a section presenting the results from a survey used to validate the new knowledge management system (KMS). We use the discussion chapter to connect the research questions to theory and results. The paper is then summarized in a conclusion including suggestions for further work.

Research Methodology

The research method used in this paper is action research. We used an ongoing project within the company as a case study. Willis and Edwards (Willis & Edwards 2014) defines action research as "a form of systematic investigation that typically involves attempts to solve practical problems in real world settings through the involvement of stakeholders who work or live in those settings".

The main researcher worked as a systems engineer in the small company for two and a half years prior to this research. We identified an industrial problem with a clear potential for improvement together with the management team. We then established a problem statement and research questions based on this. The main researcher combined research with his engineering activities in the company. We used these hands-on experiences actively in the KMS development process. The main researcher was careful to maintain a necessary distance to the company when conducting his research activities, this included asking critical questions and objectively evaluating data collected.

Interviews is a method relying on information provided by other people. The method offers an opportunity to interact with the person being interviewed and reduces the possibility for misunderstandings (Muller 2013). We used one-on-one interviews to define several requirements for the new knowledge system. We performed the interviews in a semi-structured way and had prepared questions in advance. We interviewed the general manager and a project manager, in addition to a document controller and an office assistant that were engaged in the company on an hourly basis. The employees were encouraged to share previous experiences and ideas and visions on how the system should be designed. We gave the interviewed employees an opportunity to comment on the requirements when they had been established.

A literature review can be used to identified necessary theory and "provide the foundation for the study" (Rocco & Hatcher 2011). We developed the KMS system in an iterative process where theory from the literature review were combined with frequent feedback from employees. Figure 3 illustrates this iterative process in the green box. We applied the new KMS on an ongoing project in the company and frequently used examples from this case during the KMS development process.

We used a survey to validate the new KMS. Survey is a method used for collecting data and usually carried out as one-way communication (Muller 2013). We created a survey with multiple choice answers based on The Likert Scale. The Likert Scale provides six different choices to select from: strongly agree (SA), agree (A), neutral (N), disagree (D), strongly disagree (SD) or not applicable (N/A). We analyzed the survey by using Net Promoter Score (NPS). NPS is a method used to evaluate survey results and provides a positive or negative reaction towards a statement (Muller 2013). The NPS score of a question is calculated by subtracting the number of detractors (N, D and SD) from the number of promoters (SA). Passives (A) are given a value of 0. We gave the survey to the same four people that had been interviewed earlier in the research study.

We used the research approach illustrated by eight different activities in Figure 3. The employees actively participated in the industrial problem, in-depth interviews, feedback from stakeholders and survey. These activities are marked with yellow in Figure 3. We used the information provided by employees to conduct the activities of problem statement and research questions, literature review, developing the KMS and applying the KMS on a case. These activities are marked with blue in Figure 3.

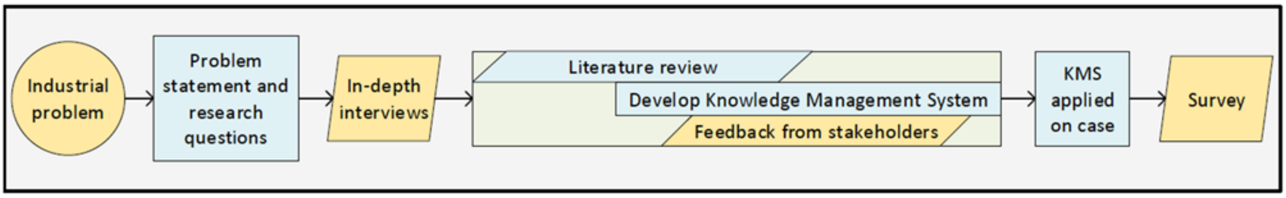

Figure 3: Research approach

Literature Review

Introduction. We used a literature review to establish the necessary research foundation, as suggested by (Rocco & Hatcher 2011). This chapter presents theory that was identified in the literature review.

Knowledge management (KM). KM is a field focused on the concepts of data, information and knowledge. Data is a set of collected facts or numbers related to a certain event. For data to have a purpose, it must be used to develop information. Information is processed data, making it understandable and valuable in a certain context (Sols 2014). (Sols 2014) defines knowledge as "information in action – the skills and understanding gained through education and/or experience" and KM as "the process of developing, sharing, using, protecting and discarding organizational knowledge". Implementing KM initiatives can reduce the number of times the same problem will have to be solved (Arntzen 2017).

Knowledge can be divided into tacit and explicit. Tacit knowledge is personal and hard to "formalize and communicate" (Nonaka 1994). Explicit knowledge is codified and can be formally transferred (Nonaka 1994). There are four modes of knowledge conversion (Nonaka 1994). These modes are illustrated in Figure 4. Socialization converts tacit knowledge to tacit knowledge, externalization converts tacit knowledge to explicit knowledge, combination converts explicit knowledge to explicit knowledge and internalization converts explicit knowledge to tacit knowledge (Nonaka 1994).

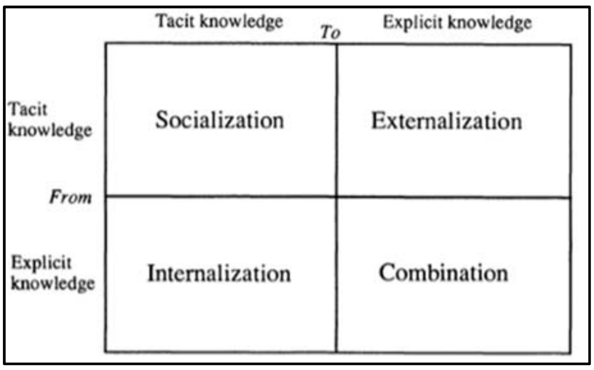

Figure 4: Modes of knowledge creation (Nonaka 1994)

Employees that are part of a project will acquire competencies and skills. Certain steps should be carried out at the end of a project to make sure that this knowledge is available for later use. This enables knowledge to be transferred from projects to the routine organization (Disterer 2002). Lessons learned and especially analysis of failures and mistakes are important information for later projects (Disterer 2002).

KM in small and medium-sized enterprises (SMEs). (The Confederation of Norwegian Enterprise 2019) defines companies with more than 100 employees as large, between 21-100 as medium-sized and 1-20 as small. SMEs in Norway employs 47 percent of people working in private sector and accounts for nearly 50 percent of Norway´s yearly value making (The Confederation of Norwegian Enterprise 2019). Previous research indicates that SMEs have different KM related challenges than large enterprises (Desouza & Awazu 2006, Wong & Aspinwall 2004, McAdam & Reid 2001, Sparrow 2001).

SMEs often have limited amount of resources, both financial and human, and therefore need to be agile in the market (Wong & Aspinwall 2004, McAdam & Reid 2001). Limited resources make it important to embody and disseminate knowledge. This is done by transforming tacit knowledge into explicit knowledge (McAdam & Reid 2001). SMEs are often presented with an intense market situation, while large enterprises commonly have a One-to-One or One-to-Few competitor situation (Wong & Aspinwall 2004).

One of the greatest challenges for SMEs is knowledge loss. When employees leave the company all knowledge that is not captured, codified and shared will be lost (Wong & Aspinwall 2004). Personal growth and career advance possibilities can be used to keep employees at a company (Wong 2005). Managers and owners in SMEs often need to reach a point of fear for a future difficulty before they take action (Sparrow 2001).

SMEs had a low degree of focus and understanding of KM compared to large enterprises (McAdam 2001). (McAdam 2001) concluded that "*the SME sector would appear to need to develop their understanding of knowledge management further as a key business driver rather than as a resource-intensive additional initiative*". Proper KM can offer SMEs a competitive advantage (Wong & Aspinwall 2004). (Wong 2005) identified five different categories related to KM in SMEs: ownership and management, structure, culture and behavior, systems and procedures and human resources. (Wong 2015) concludes his research with a suggested definition of KM in small companies: "The management of knowledge-related processes or activities, based on *realistic resources* in order to create competence, value and continual success for the organization".

Lean Thinking (LT). LT is a concept concentrated on continuous improvement by increasing value and reducing waste. It includes elements from Total Quality Management, Concurrent Engineering and Six Sigma (Oppenheim 2010). The concept is based on the Toyota Production System and gained popularity from the book *The Machine that Changed the World, the Story of Lean Production* which was released in 1990 and its sequel *Lean Thinking* released in 1996. (Oppenheim 2010) defines LT as "the dynamic, knowledge-driven, and customer-focused process through which all people in a defined enterprise continuously eliminate waste with the goal of creating value" and value as "the delivery of a complex system satisfying all stakeholders, which implies a flawless product or mission delivered with at minimum cost, in the shortest possible schedule, fully satisfying the customer and other stakeholders during the product or mission lifecycle". The combination of lean and systems engineering has been named lean systems engineering (LSE) (Oppenheim, 2010).

The A3 reports is a lean tool developed by the Toyota Motor Company. It is used to present essential information about a certain topic using the space available on a A3-sheet. Information can be presented by visual models and text. The tool is used for several different purposes, such as Knowledge Sharing A3s, Proposal A3s, Status Report A3s and Customer Interest A3s (Welo 2013).

(Raudeberget & Bjursell 2014) addressed A3s as a tool for codification, transfer and creation of knowledge. The goal was to develop a tool that could reduce development time and cost by enabling knowledge sharing and reuse. (Raudeberget & Bjursell, 2014) presented a knowledge management structure built up of several interconnecting A3s. The "Guideline A3" was suggested to provide general insight and overview, with more detailed and specialized information being presented in "Design standard A3s" (Raudeberget & Bjursell 2014).

A3 reports have been used for different purposes in several research papers at the University of South-Eastern Norway (USN). (Singh & Muller 2013) combined lean manufacturing principles and model-based systems engineering to develop a Dynamic A3 Architecture (DA3A). The authors concluded that DA3As facilitated communication, understanding, early validation, employee training and knowledge capture (Singh & Muller 2013). (Nilsen & Muller 2013) used Compact System Description A3s (CSDA3s) to communicate system information to stakeholders and concluded that different system viewpoints increased understanding of single viewpoints. (Svendsen & Haskins 2016) found A3s to be a reliable, simple and adaptable tool when used for problem solving. (Frøvold, Muller & Pennotti 2017) applied A3 reports consisting of models and text for early validation and stakeholder communication and found the method to increase understanding and motivation and help the process of early validation.

(Borches 2010) studied the concept of A3s and developed a tool called A3 Architecture Overviews (A3AOs). A3AOs presents a system by different views such as physical view, functional view and quantification. Knowledge sharing requires information to be made explicit and that the large amount of text documents created by most companies is an inefficient way to share knowledge (Borches 2010). A3AOs uses both sides of an A3, with one side presenting a structured model and the other side relevant textual information. (Borches 2013) found the A3AO structure to be "more readable, easier to understand, more usable, and with more adequate information" than traditional documents. A3AOs uses colors to make the presentation appealing and information is limited to maintain a system viewpoint. The font size is kept readable and consistent and all blocks are sectioned clearly without a weird size. Pictures and drawings were favored over text and open spaces were not be filled "just to do so". (Borches 2010) suggests that different A3s can be linked together by direct links, hierarchy links or related system aspect links. (Borches 2010) developed A3AOs for systems architecting, but it was stated that the findings also could be implemented to fit other purposes (Borches 2010). (Viken & Muller 2018, Løndal & Falk 2018, Wiulsrød, Muller & Pennotti 2011) found the principles of A3AOs to facilitate communication and knowledge sharing.

Business model (BM). A BM can be defined as "the rationale of how an organization creates, delivers and captures value" (Osterwalder & Pigneur 2010). (Osterwalder & Pigneur 2010) identifies nine elements that should be included in a BM. These are customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structure. (Osterwalder & Pigneur 2010) presented these elements in a tool called the Business Model Canvas (BMC). The BMC is a single sheet of paper, preferably large, divided into nine blocks with a purpose to "foster understanding, discussion, creativity and analysis" (Osterwalder & Pigneur 2010).

Results and Analysis

In this chapter, we present the results and analysis of this paper. The company under investigation has an ongoing project of a medium sized wastewater treatment plant. We used this project as a case study. Detail engineering was recently completed, and we were provided with most of the information required in the new KMS. We validated the new KMS by a final survey.

KMS requirements. We established seven requirements for the new KMS based on information gathered through interviews with a general manager, project manager, document controller and office assistant. We gave the requirements a priority of high and medium. Table 1 presents the requirements and their priority.

Table 1: KMS requirements

No.	Priority	Requirement
1	HIGH	The system shall facilitate knowledge reuse
2	HIGH	The system shall present knowledge in a way that is easily understood for employees previously unfamiliar with the project
3	HIGH	The system shall provide essential project knowledge
4	HIGH	The system shall be usable for all projects within the company
5	MEDIUM	The system shall require low effort to be used
6	MEDIUM	The system shall require low effort to be created
7	MEDIUM	The system shall be created with the use of already available or easily accessible tools

KMS structure and contents. Previous research has proven A3 reports to be an effective tool to communicate knowledge. The new KMS has a structure that was inspired by the Guideline A3 and Design Standard A3 presented by (Raudeberget & Bjursell 2014). This way of linking A3-sheets is supported by (Borches 2010). The new KMS has a structure of interconnecting A3s that combines a general overview with detailed information. The new KMS structure that we developed is presented in figure 6.

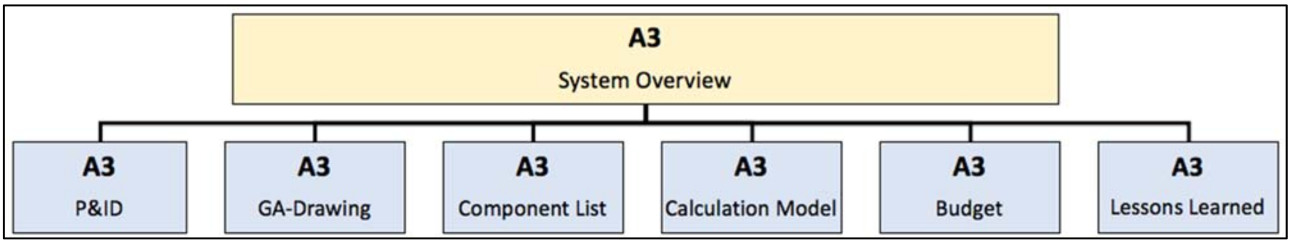

Figure 6: New KMS Structure

The KMS is built up of seven different A3s. We developed one top A3 that gives an introduction to the system by providing a system overview, and six sub-A3s that presents detailed information. Feedback from employees were especially important when selecting which A3s to include. We included five A3s that were developed by the project team as a part of the project execution process. This was to minimize the effort required to create the system. These are the P&ID, GA-Drawing, Component List, Calculation Model and Budget. The Piping and Instrumentation Diagram (P&ID) provides a detailed presentation of the system architecture. The General Arrangements (GA) Drawing is an overall design drawing of the system. The Component List is a sheet presenting all components and relevant information such as supplier, manufacturer, model and delivery time. The Calculation Model is a mathematical model used to dimension the different parts of the system. The Budget is a calculation model that presents the system costs. The Lessons Learned A3 is included as recommended by (Disterer 2002). The Lessons Learned A3 is made at the end of the project, in a workshop where key personnel from the project organization participates. This workshop will seek to identify project failures and mistakes, and why this what the outcome. Other information that is important for later projects will also be included.

We created the A3 System Overview (A3SO) as a top A3 to give employees an introduction to the project and provide essential information while maintaining a system overview. We combined feedback from employees with theory and previous research on A3 reports, A3AOs and the BMC. We designed the A3SO with appealing colors, a readable and consistent font size and a clear sectioning of blocks, as recommended by (Borches 2010). The template A3SO is illustrated in Figure 7.

The A3SO includes a title, name of author, date and revision. We included these elements to ensure traceability and document control. Most A3 focused research papers includes one or more of these elements. (Viken & Muller 2018) included title, author and date, (Løndal & Falk 2018) included title and author, (Svendsen & Haskins 2016) included title, date and author, (Borches 2010) included title and author, (Singh & Muller 2013) included title, author, revision and date. We considered to include author contact information, but decided against it, as the author almost always will be part of the project organization and have his contact information presented in the project organization block.

The A3SO is built up of eight blocks that combines text and model illustrations. These blocks are document structure, key information, key suppliers, literature, physical view, project organization, project schedule and system description. The size of these blocks can be adjusted depending on the project. We explain the eight blocks below.

Document Structure. We included a model to illustrate the document structure of the KMS. The employees are able to navigate and understand the documents included in the KMS by using this model. (Nilsen & Muller 2013) presented a map that could be used to understand the relationship between a set of A3s and (Løndal & Falk 2018) a block to list relevant documents.

Key Information. We created a block called key information that presents the most important project details in a bullet-point summary. The key information block includes type of system, type of contract, start date, end date, customer, customer contact person, delivery address and project value. We included this block based on feedback from employees.

Key Suppliers. We considered the key partnership element in the BMC and adapted it to a key supplier block in our A3SO. This block presents a list of the key suppliers for the system.

Literature. We added a literature block that includes the most essential sources of information for the project. This can be tender documents, books, research study papers, guidance documents, standards etc. (Borchers 2010) included a block titled references for similar purposes.

Physical View. We illustrated the physical view by a 3D-model and a 2D-model. We included both, as the combination gives a good understanding of the system. Employees preferred the combination over only including one of them. (Borches 2010) suggests the use of models to illustrate the physical view. 3D-models in A3 reports are included in the papers of (Singh & Muller 2013) and (Svendsen & Haskins 2016). (Nilsen & Muller 2013) included a 2D-model in the final A3 version.

Project Organization. We included a block that presents a hierarchy diagram of the key employees in the project organization, with their position and contact information (e-mail and phone number). The BMC key resources element inspired this block. We also received feedback from employees that strongly supported that we included this section.

Project Schedule. We observed that projects at VIM often were delayed in time and the information in this block could therefore be of less value for future projects. The employees at VIM wanted it to be included, and we regard it as an important block when the company have a more consistent timeframe for projects. The block presents the project timeline by activities and milestones. Every activity is assigned with a certain time frame.

System Description. We use the system description block to provide the reader with a textual summary that creates a general understanding of the system functionalities. The main functionalities are quantified and can be related to the quantification aspect described by (Borches 2010) and the block titled "Function Goal" in the A3 of (Løndal & Falk 2018).

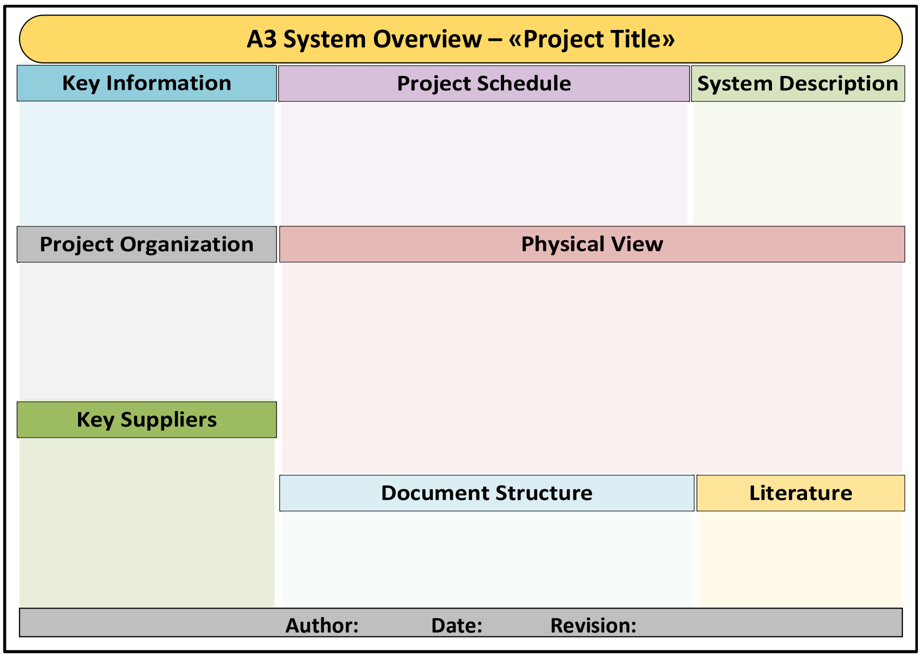

Figure 7: A3 System Overview (A3SO)

We created an A3SO for the project that is presented in Figure 8.

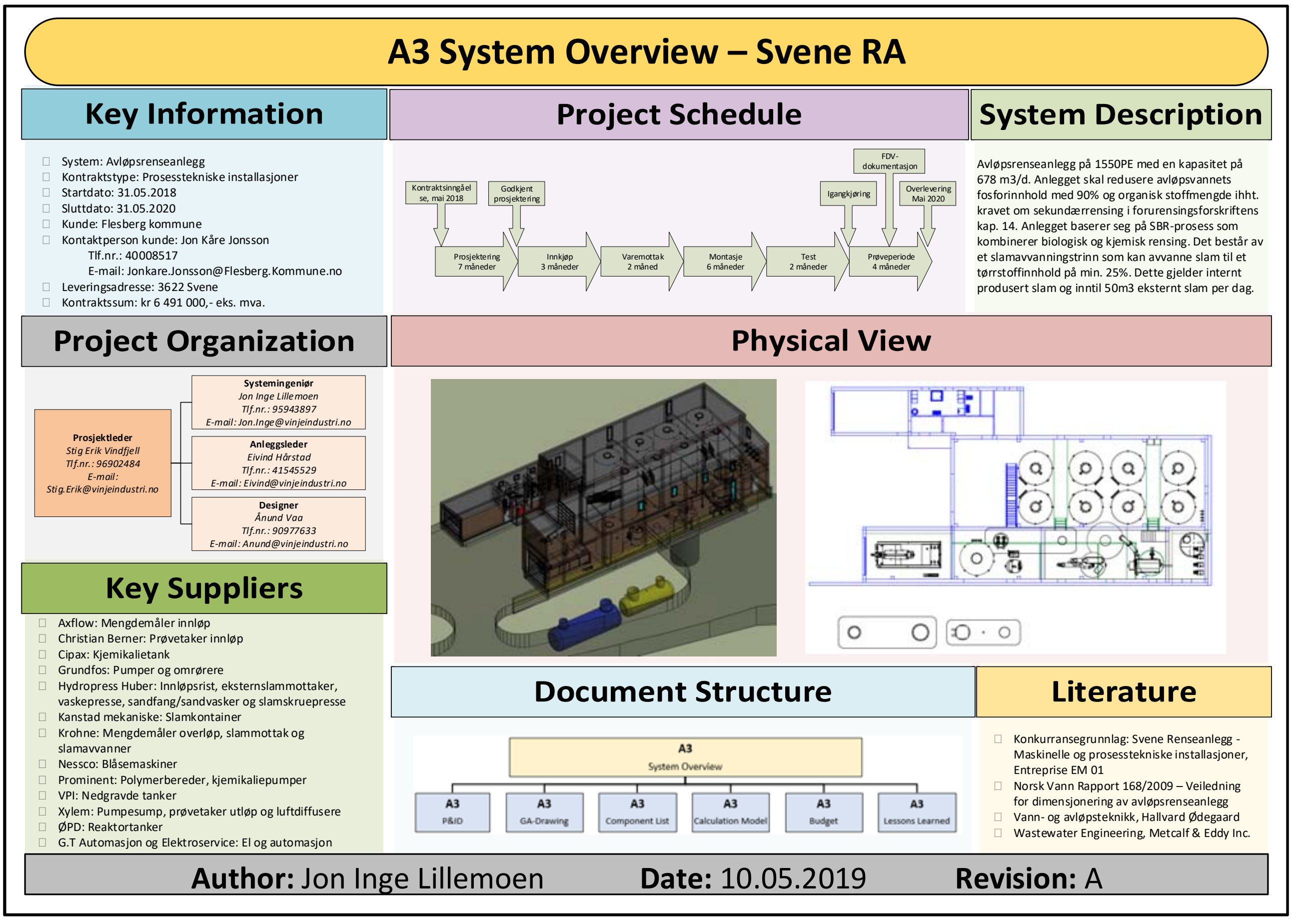

Figure 8: A3 System Overview (A3SO) – Svene RA

We applied the Knowledge Management System (KMS) to the wastewater treatment plant. This we did after the system was completed. Unfortunately, we were unable to carry out the workshop intended for lessons learned, as the project was still ongoing. However, the P&ID, GA-Drawing, Component List, Calculation Model and Budget A3s were already established, and we could implement them without much effort. The sub-A3s contain confidential information, and are not included in this paper.

Validation of the New Knowledge Management System

We conducted a final survey to validate the KMS. We thoroughly presented the KMS before handing out the survey. The presentation included the KMS structure and a detailed explanation of the different A3s. We also included the case study A3s in this presentation. The survey results are presented in Table 2.

Tabell 2: Final survey

No.	Question	SA	A	N	D	SD	N/A	NPS
1	The KMS facilitates knowledge reuse	**4**						**4**
2	The KMS presents information in a way that is easily understandable	**3**	**1**					**3**
3	The KMS system provides an overview of essential project knowledge	**3**	**1**					**3**
4	The KMS provides essential detailed project knowledge	**1**	**3**					**1**
5	The KMS can be used for different types of projects within the company	**4**						**4**
6	The effort required to use the KMS is acceptable	**3**	**1**					**3**
7	The effort required to create the KMS is acceptable	**2**	**2**					**2**
8	The KMS only requires tools that are easily accessible	**4**						**4**

The employees strongly agreed that the KMS facilitates knowledge reuse (No. 1), can be used for different types of projects within the company (No. 5) and that it only requires tools that are easily accessible (No. 8). They also agree that the KMS presents information in a way that is easily understandable (No. 2), provides an overview of essential projects knowledge (No. 3), provides essential detailed project knowledge (No. 4), the effort required to use the system is acceptable (No. 6) and that the effort required to create the system is acceptable (No. 7). We exemplified the different types of projects by water treatment plants and pumping stations. The tools needed for the KMS are Microsoft Visio, Microsoft Excel, and Autodesk Inventor.

Question No. 4 received the lowest NPS on the survey. We asked the employees why they only selected agree on this question. They explained that the KMS provides the level of detail they expect from such a system, but that there still are documents and information left out. The employees do however not think that the documents and information left out should be included in the KMS.

Questions No. 7 addresses the effort required to create the KMS. We included this question but did not make the employees actually create the KMS for a project themselves. We decided against this, as the system is quite understandable, and the employees should be able to estimate the effort needed. The employees also have a high workload, and we felt that it could be disadvantageous to force such a workshop given the positive atmosphere surrounding the research process.

The survey displayed that the employees generally have a strong positivity towards the KMS. We also observed that questions related to the initial requirements with a high priority (No. 1,2,3,4,5) received an average NPS of 3, the same as the questions related to the initial requirements with a medium priority (No. 6,7,8).

Discussion

Creation process. This paper presents a KMS that combines theory with feedback from stakeholders at VIM. VIM is a small company with employees heavily occupied in ongoing projects. We therefore selected a research approach that combined continuous feedback in informal settings with an initial interview and a final survey. This proved to be a successful strategy, as we were able to attain the necessary information without demanding too much time of the employees. The employees were positive towards to research, and willing to provide information when needed. We gathered feedback when employees had time available, such as in the hallway, before and after meetings, during lunch time etc. We could observe that the positivity towards the research increased with time. We believe this is related to them feeling that the KMS was purposeful and that we conducted the research in an agile way adapted to their work situation.

The new KMS. We developed a KMS that can be used by VIM to facilitate knowledge reuse. VIM is a small company and the internal knowledge sharing process is mostly through socialization. The KMS provides a way to convert knowledge from tacit to explicit and make it property of VIM. Employees at VIM were previously unfamiliar with using A3s, but after being explained the concept, we observed them accepting it as a tool for effective communication of knowledge.

We validated the new KMS by using a survey. The employees were generally positive, and only selected strongly agree and agree on questions. We designed the new KMS to provide a quick and simple way to reuse project knowledge in similar projects. We believe that the overall NPS will be reduced if there is a change in balance between quality and effort, and level of detail and maintaining an overview. The employees will improve their understanding of the KMS with use, and this should result in increased positivity towards the concept. The survey results indicate that the KMS will have a high possibility of being successfully implemented in VIM. The KMS will however have to overcome certain barriers.

KM barriers in VIM. VIM is presented with different barriers than large companies, as presented by (Desouza & Awazu, 2006). VIM currently only has four employees and they all have heavy workloads. The financial resources in the company are also limited. The employees of VIM have limited KM understanding and experience, which is common for employees in small companies (Wong & Aspinwall 2004, McAdam 2001). Limited time, financial resources and KM understanding will likely prevent KM initiatives from being prioritized. We believe that educating employees on KM and its benefits will be important. The employees have long work experiences and can be resistant to changing their mindset, this requires the KM initiatives to be presented and adapted properly. Implementing the KMS can be perceived as increased and unwanted formalization. The general manager at VIM is participating in the daily operational activities, often "fire-fighting", which can prevent him from maintain the necessary overview needed to acknowledge the benefits of KM.

Benefits of implementing the KMS. VIM is vulnerable to loss of knowledge, making it a critical factor. The new KMS provides VIM with a system to retain critical knowledge within the company. The research presented in this paper indicates that the new KMS will reduce the number of times VIM has to solve the same problem, as suggested by (Arntzen), which will reduce the company's unnecessary waste. VIM has several competitors in the water treatment industry, resulting in an intense market situation. Focus on KM will provide VIM with an opportunity to achieve a competitive advantage, as suggested by (Wong, Aspinwall, 2004).

Limitations. The research presented in this paper only considers one company with a small number of employees. We conducted a thorough literature review to compensate for this, but it is necessary to validate the results on other small companies and in different industries. VIM has a project portfolio that did not allow us to test the reuse ability of the KMS fully. The next step is to test the documents generated from the case study on similar projects to observe how well knowledge is reused. We provided relevant theory from a literature review, but the quality of the information gathered cannot be guaranteed. The survey results can be influenced by certain factors. Employees can be enthusiastic about the method and give overly positive answers, as enthusiastic does not necessarily mean "good" (Muller 2013). The main researcher is employed at VIM and has a personal relationship with the employees participating in the survey, which may affect their answers.

Future research. This paper presents promising results related to the implementation of KM initiatives in a small company. For future research, we suggest further investigation on knowledge management in small companies, and the usefulness of both the new KMS and other tools in KM theory that we did not discuss in this paper. The KMS can be tested on small, medium-sized and large companies.

Reflection. This research paper has provided VIM with a new KMS that can facilitate knowledge reuse. Previous research that combined KM and A3 reports proved promising results. We further developed this research and added the element of a small company. We developed a new KMS that combined theoretical aspects from different fields with the feedback received from employees at VIM. We observed different challenges related to the successful implementation of the KMS. The discussion chapter presents barriers, so that additional focus can be applied to these factors. We also present benefits of implementing the system, as these will be essential in convincing management and employees at VIM that KM efforts are beneficial.

Conclusion

The objective of this research paper was to provide VIM with a new KMS that facilitates reuse of knowledge. The new KMS developed relies on easily accessible tools and requires low effort. We developed the new KMS based on identified theory and tools proven in previous research and combined this with feedback from employees at VIM. We applied the small company aspect to previous research. We used a final survey to validate the results. The survey results proved that the new KMS should have a high chance of being properly implemented at VIM.

VIM is a small company and we observed that four employees and limited resources forced urgent tasks to be prioritized. Our research indicates that initiatives without immediate effects, such as KM, will be neglected if the employees are not properly convinced of the benefits. Employees with substantial work experience are especially prone to resist change. The key to a successful implementation is management acceptance of KM benefits and that they allow employees to investigate KM and increase their KM understanding. VIM can use the new KMS to prevent loss of company knowledge and reduce the resources required in new projects. A successful implementation will provide VIM with crucial benefits in a market with fierce competition.

Our results provide information on how knowledge related initiatives can facilitate knowledge reuse in small companies. The paper presents a contribution in understanding the differences between implementing such initiatives in small and large businesses.

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Biography

Jon Inge Lillemoen. Jon Inge Lillemoen received his bachelor´s degree in Process Technology from the University of Tromsø - The Arctic University of Norway in 2016. He has been working as a Systems Engineer in Vinje Industri Miljø AS since 2016. Vinje Industri Miljø AS is a company operating in the Norwegian water and wastewater treatment industry. This paper is the result of research done for his M.Sc. in Systems Engineering at The University of South-Eastern Norway.

Kristin Falk. Professor Kristin Falk has lead technology teams in start-ups, SME and large corporations, primarily in the energy industry. She has been in the industry for more than twenty years. She is teaching Systems Engineering at the University of South-Eastern Norway. Her research focus is 'how to create systems fit for purpose in a volatile, uncertain, complex, and ambiguous world'.