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Streamlining Engineering in Growing SMEs: A Framework of Guidelines and Checksheets for Knowledge and Project Improvement

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Abstract. In the rapidly evolving marine automation industry, project-based small-to-medium-sized enterprises (SMEs) in the engineering field face the challenges of managing complex projects and fostering innovation amidst intense competition. This research focuses on a case study, improving and streamlining the knowledge management (KM) and project management (PM) processes in a small growth-oriented company in Norway through the development of a project guideline and checksheets. The project began with a critical evaluation of existing documentation practices and challenges perceived by the employees, identifying the need for a more adaptable and accessible set of tools. Through surveys and interviews with stakeholders, including engineers and project managers, insights were gathered on current work practices and the organisation's needs in these areas. This stakeholder engagement highlighted a preference for straightforward, easily navigable tools that support diverse project activities while enhancing efficiency and quality, whilst not consuming the time of the user. The outcome is a proposed set of a guideline and checksheets designed to enhance PM and knowledge sharing. Developed through a collaborative process, these tools simplify complex tasks, gives the user an overview of the entire process, ensure documentation consistency, and provide intuitive access to key information, directly addressing the organisation's operational needs. The approach not only aligns with the organisation's strategic goals and engineering processes, but is expected to significantly improve daily operations, facilitating more effective team alignment and process efficiency.

Keywords. Project Management, Process Improvement, Guidelines, Checksheets, Documentation, Operational Efficiency, Quality Assurance, Knowledge Management, Knowledge Sharing.

Introduction

In today's rapidly evolving industrial landscape, small and medium-sized enterprises (SMEs) face growing pressure to manage increasingly complex projects while staying compliant with ever-tightening regulatory standards. Across sectors, knowledge loss, inconsistent documentation, and ad-hoc project management approaches contribute to delays, cost overruns, and reduced competitiveness. These challenges are particularly pronounced in industries undergoing fast-paced technological shifts, such as maritime automation, where sustainability demands, digital transformation, and operational safety intersect. Despite their agility, many SMEs struggle to establish scalable systems for knowledge and project management that can adapt to such complexity. This paper explores these challenges through the lens of a Norwegian SME in the marine automation industry, using it as a representative case to highlight systemic issues and evaluate practical tools that may benefit similar organisations globally.

System-of-Interest. This study aims to address these systemic challenges by identifying critical operational issues and laying the groundwork for developing a more adaptable and efficient KM and PM approach in technology centric SMEs. The research focuses on developing a project guideline paired with checksheets, aiming to enhance the project and process management within the industry by offering a balanced approach to standardisation and flexibility for diverse project demands.

The guideline serves as a standardised document designed to streamline efficient project execution based on identified best practices, with an emphasis on understandability and usability. Checksheets complement the guideline by simplifying task breakdowns and milestone tracking, offering engineers practical support to stay productive and aligned project goals.

Problem Statement. Existing knowledge and project management (KM, PM) frameworks are increasingly inadequate for addressing the complexity and pace of technological change. This results in operational inefficiencies, higher project costs, and difficulties in maintaining regulatory compliance. While the study focuses on a single SME, the challenges identified reflect broader issues faced by project-oriented SMEs in the maritime sector and similar industries. The findings and solutions developed through this research aim to provide insights that can be applied to other SMEs dealing with similar complexities.

Industry and Company Background. SMEs in the marine automation industry face increasing challenges related to managing complex projects, ensuring effective knowledge management, and meeting stringent regulatory requirements. These issues often result in project delays, increased costs, and the loss of critical knowledge within project teams.

Characterised by rapid advancements and a critical role in enhancing maritime operations, the evolution of the industry demands innovative approaches to PM and KM to remain competitive. This is driven by stricter environmental and safety regulations. The push for environmental sustainability has propelled ships towards hybrid propulsion and stricter requirements for emission and consumption data management, presenting new challenges for companies to innovate, adapt, and manage new knowledge.

This study focuses on a Norwegian SME with a global footprint, operating within this industry and managing a variety of complex automation projects, including vessel newbuilds, retrofits, and standalone systems tailored for diverse vessel types. Similar to many SMEs, the company struggles with inconsistent documentation practices and ad-hoc project management approaches, leading to inefficiencies and knowledge gaps. Handling technically advanced projects and managing sophisticated automation systems adds a level of complexity that demands high adaptability, particularly for new or less experienced engineers.

Research Questions. The research focuses on developing a structured guideline and supporting checksheets to enhance KM and PM practices. The study addresses the following research questions:

- RQ1: What specific knowledge management inefficiencies in project documentation and communication hinder project management effectiveness?
    - This question aims to identify and understand specific shortcomings within the case company's project documentation and communication processes, focusing on where knowledge is poorly managed or lost, thereby impacting project efficiency and outcomes.
- RQ2: How can the development of a tailored guideline and accompanying checksheets address these inefficiencies and improve project management practices?
    - This question focuses on developing practical solutions, such as guidelines and checksheets, to address the problems identified in RQ1. The solutions aim to enhance knowledge capture, sharing, and utilisation across projects.

Structure of the Paper. In response to the identified challenges, this research develops and applies tailored guidelines and checksheets to enhance PM. These tools provide structured methods to streamline documentation and improve knowledge sharing. The guideline offers a comprehensive framework

for project execution, while the checksheets serve as practical checkpoints to ensure no critical steps are overlooked.

The paper proceeds as follows: the literature review situates the project within existing research and industry practice, highlighting the need for improved PM approaches. The methodology section outlines stakeholder engagement and the development of the tools. This is followed by their implementation, findings from their use, and a discussion of the results in the context of industry challenges. The paper concludes with key insights and recommendations, emphasising the tools' potential to evolve and adapt alongside industry developments and maintain long-term relevance.

Literature Review

Project Management. Project management is a crucial part for the success of SMEs. The main activities of the case company in this research are project based, a so-called project-based organisation (Bartsch, Ebers & Maurer 2013). A common recurrence in SMEs is that they may have less developed procedures, and struggle more with resources; a single employee may be a key player in the engineering phases of a project, whilst at the same time being responsible for managing PM tasks (Rodney Turner, Ledwith & Kelly 2009). However, at the same time, such organisations may be more agile and flexible, and more receptive for changes (Turner, Ledwith & Kelly 2010). It has been found that SMEs have poor PM practices, and to be successful, research has identified that they need to carefully select their PM practices by identifying tactical objectives, appropriate PM techniques and tools (Rodney Turner, Ledwith & Kelly 2009).

PM as a field has historically been developed for larger engineering industries, but it has evolved over time to be more suitable for smaller projects and companies and thus their requirements will differ (Rodney Turner, Ledwith & Kelly 2009; Turner, Ledwith & Kelly 2012). However, Rodney Turner et al. (2009) does not take into account SMEs that primarily runs small-to-medium sized projects, which at least in the Nordic countries and the maritime field tends to be smaller in size. This is important because SMEs may spend 30-40 percent of their turnover on projects (Turner, Ledwith & Kelly 2012).

Of relevance to PM in SMEs, Hussain et al., and Sarayreh and Khudair (2018; 2013) discusses the importance of the change management theory and in how the leadership style and involvement of employees are important for implementing changes to processes in an organisation. During this process, employees and managers work together on implementing changes, and along the way facilitate knowledge sharing. This is dependent on the leadership of management, as good leadership is needed to support the participation of individuals in accelerating change in an organisation, such as through communication, involvement, education, and emotional support (Hussain et al. 2018).

Knowledge Management. Knowledge creation in organisations is the process of promoting and enhancing knowledge created by individuals, crystallising and linking it to an organisation's knowledge system (Nonaka, von Krogh & Voelpel 2006). In the knowledge-creation theory, epistemology – the theory of knowledge and its study of validity, methods and scope – and knowledge conversion are central elements (Nonaka, von Krogh & Voelpel 2006).

Nonaka et al. (1996) discusses in their paper the difference between tacit and explicit knowledge. In the case of SMEs, such as the case company, knowledge is present in the form of tacit knowledge, which is innate knowledge acquired over time through experiences (Nonaka, Takeuchi & Umemoto 1996). In order to have a successful way of transferring this knowledge from person to person, one need to perform externalisation, to articulate tacit knowledge into explicit concepts, and this may require a considerable time-investment (Baptista Nunes et al. 2006; Nonaka, Takeuchi & Umemoto 1996). SMEs tend to have most of their knowledge as tacit knowledge, which requires close attention, as insufficient time may be detrimental for knowledge transfer (Didenko & Suarez Pliego 2015). They tend to focus on tacit knowledge management, with few internal communication channels, and with management often limited by the amount of time they can allocate for KM, challenges arise (Durst & Runar Edvardsson 2012). Desouza and Awazu (2006) in their paper describes that many SMEs don’t consider knowledge loss a

problem, as the core knowledge often sits with the owner or managers, and common knowledge is spread throughout the organisation. Anand et al. (2021) found that knowledge sharing and knowledge transfer in SMEs are involved in enhancing learning, performance, and innovation whilst contribution to a higher profit and positive effects on operational processes.

Existing research suggests that SMEs often struggle with KM, and the sharing and transfer of knowledge, leading to it often being disregarded (Ahmad & Bergsjö 2021; Baptista Nunes et al. 2006). It is often a focus area that is not prioritised because of time, cost and resources, and erroneous decisions will bring more serious complications than in larger organisations (Ahmad & Bergsjö 2021; Durst & Runar Edvardsson 2012). The advantages of SMEs are flat structures that are often guided by a free management style that encourages entrepreneurial and innovative spirit (Durst & Runar Edvardsson 2012). It is also regarded that using knowledge in an efficient way is how smaller organisations can remain competitive (Desouza & Awazu 2006). However, challenges may arise as these organisations are often informal and non-bureaucratic, with few rules and formal policies, and control is based on individuals' own supervision (Durst & Runar Edvardsson 2012).

Documentation. The way organisations handle documentation varies from company to company. The case company evaluated in this research utilises digital tools to store documentation, but it is still handled in a very manual way. This research is looking for a way of breaking down an entire project process into smaller, more manageable parts to improve on this, but research seems to be lacking in this area, at least for small-to-medium project SMEs. For these tools to address the knowledge management inefficiencies and improve the project management practices, it was investigated how these should be made in a better way to make them more accessible, flexible, and maintainable. To aid in this, systems theory can be used as it focuses on viewing the processes as a collective system working as a single entity, built up by a set of related elements (Whitaker & Mancini 2012). In the case company, it was noticed that several projects often experienced delays and extra work to fix mistakes, which can be linked to flaws in the documentation practices and in the way of working (Tilley & Barton 1997). A well-known term in KM that is important to note in this research is *tacit* knowledge, innate knowledge of which a person has built through experiences (Alwazae, Perjons & Johannesson 2020). This type of knowledge is more challenging to share than explicit knowledge which usually can be stored in a written format (Alwazae, Perjons & Johannesson 2020).

Quality Assurance and Compliance. Another important motivation for the research is the quality aspect and the assurance of documentation and deliveries. This includes compliance with rules and regulations from classification societies such as DNV, BV, ABS, and others. The ISO 9001 standard is widely used and has the purpose to help organisations grow systematically while ensuring a set of quality standards in the project deliveries (Aldowaisan & Youssef 2006). The guideline and checksheets are a step in the direction of aiding with quality assurance (QA), by establishing a framework of working and best practices. As an example, the checksheets should be quality controlled by another colleague, ensuring that the tool maintain the quality aspect.

Operational Efficiency and Innovation. Some challenges with innovation in SMEs include a limited cash flow, a limited number of people with crucial knowledge and skills, and a lower sales volume of which the innovation costs can be dispersed (Rodney Turner, Ledwith & Kelly 2009). Applications of PM and process improvements are regarded as the most cited work in research, and are particularly important in smaller organisations (Krndzija & Pilav-Velic 2022; Pertuz & Pérez 2021). Innovation is closely linked with other influences such as knowledge acquisition and the capacity of which knowledge is absorbed by the individuals in the organisation (Wang, Wang & Horng 2010).

Conclusion and Research Gaps. Knowledge-based theory is considered an important part of understanding how knowledge should be captured and treated to facilitate knowledge reuse and improving project processes, which is highly relevant to the case company (Nonaka, von Krogh & Voelpel 2006; Nonaka & Toyama 2003). After the literature review it was discovered that the use of checksheets is a relatively new concept (Bergsjö, Catic & Stenholm 2021), which is not found in many SMEs. Research in this area is missing, as existing research suggests that checksheets currently in use are principally

used by larger, product-based organisations. The guideline and checksheets being developed in the case company seem to fill a gap that has not yet been fully explored in existing literature. In the following sections there will be a deeper look into how such a guideline and checksheets are being designed to accommodate the diverse needs of both junior and senior employees in SMEs. Regarding challenges in operational efficiency and innovation, the guideline and checksheets can be seen as an innovation for resolving issues with both PM and process shortfalls. To refer back to the paper by Rodney Turner et al. (2009), the checksheets can be seen as a tool to improve and increase the efficiency of PM practices and techniques.

Research Methodology

The research followed a mixed-method approach, using interviews, workshops, and informal workplace conversations, making it qualitative in nature (Figure 1). This approach suited the research questions by enabling a deep exploration of PM inefficiencies, documentation practices, and KM shortfalls. Qualitative methods like semi-structured interviews and facilitated workshops provided insight into not just what and how, but also why current practices exist. These insights were crucial for developing solutions tailored to the company's challenges. The method also captured subjective experiences essential for evaluating current systems. The research method applied is called the Design Research Methodology, DRM (Blessing & Chakrabarti 2009). It is a framework for mixed methods suitable to research within engineering design companies especially including aspects of participatory research methods. Notably, the researcher conducting the research was also employed by the company, combining academic and operational roles.

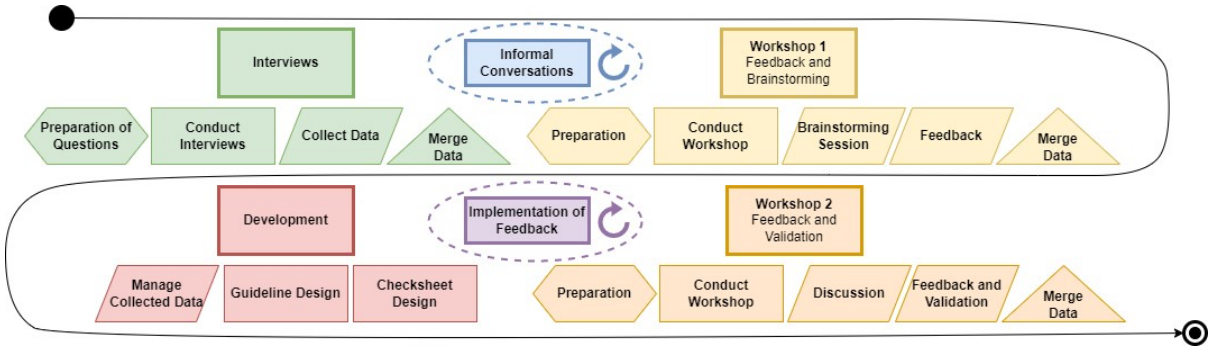

Figure 1: Research Methodology Process

Data Collection. Data was collected mainly during interviews and workshops in 2023 to 2024. A selection of stakeholders was invited to the interviews, differing both in seniority within the case company, their experience in PM, and from different departments or supporting roles. The same stakeholders were included throughout the process when available to ensure feedback at different stages. This is part of the *Research Clarification* process, as described in (Blessing & Chakrabarti 2009).

The first interviews were one-on-one, aiming to elicit the individual's perceived challenges and ways of working. Interviews were recorded and manually transcribed; specific notes and highlights were also taken during interviews. To follow up the individual interviews, a workshop was held to discuss the results. The workshop also contained a brainstorming session, aimed at better understanding how a guideline and checksheet should be designed to meet the needs of the individuals and the case company. After the workshop, time was spent developing a draft framework and design of the artefacts, before scheduling a second workshop to validate the design. The second workshop presented suggested designs for a guideline and checksheets and had the purpose to validate the design and findings.

Interviews. Individual interviews were conducted within the case company using two tailored question sets: one for project-related roles (e.g., engineers, project managers) and another for supporting roles (e.g., experts from Production, Product Development, and Supply Chain). Interviews began with open-ended questions, followed by more specific ones, with follow-ups based on emerging insights. Participants were informed of confidentiality, and all data was anonymised.

Twelve out of 22 identified employees were interviewed, mostly from project roles, with varying levels of seniority. Interviews lasted between 20 and 75 minutes, averaging 40 minutes. Data saturation was reached when responses began to repeat. Each interview yielded 250–500 words of data, and the first workshop produced about 700 words. Appendix C and D includes the questionnaire for the interviews.

Workshops. The first workshop included most interviewees and the HSEQ manager, with participants from roles such as project engineers, automation technicians, and project managers. The session began with a presentation of interview findings, followed by a brainstorming discussion and review of existing checklists. Scheduled for one hour, the workshop ran slightly over time, lasting 70 minutes as the discussion evolved naturally. Of 15 invited, 6 attended (excluding the researcher), including the HSEQ manager, two project managers, two project engineers, and one automation technician. The interview and workshop activities are part of the first *Descriptive Study* (Blessing & Chakrabarti 2009). Here, the empirical data were gathered to deepen the understanding of the problems, observing how current practices affected project outcomes. They also functioned to identifying key areas for improvement.

Development Process. In-between the interviews and the first workshop and the validation workshop, the development of the guideline and checksheets were started. The development was informed by a thorough evaluation of existing artefacts within the case company, identifying gaps and areas for enhancement. Drawing on existing research and frameworks (particularly in the context of Checksheets) provided by (Bergsjö, Catic & Stenholm 2021), the process involved synthesizing best practices with current operational needs to create the tailored tools. The development of the initial drafts for the guideline and checksheets between the workshops represents the *Prescriptive Study* stage in (Blessing & Chakrabarti 2009). Here, the focus shifted from understanding the problem to creating actionable solutions based on the insights previously gathered. The new checksheets were designed to address specific inefficiencies identified during the initial research phases, aiming to streamline workflows and improve documentation accuracy. This iterative development was guided by feedback from stakeholders to ensure the final products were both practical and aligned with the users' daily realities.

Validation of Findings. The second workshop was designed to assess the effectiveness of the developed tools by validating whether they met the stakeholders' needs and expectations. It presented the designed tools, followed by a structured feedback session where the stakeholders evaluated the tools based on their applicability, usability, and potential to address the identified challenges within the case company. The same participants were invited to this workshop, with an attendance of 8 out of 16 invited participants. A mix of project engineers, automation technicians, subject matter experts, and technical management attended. This stage involved showcasing the solutions in its intended environment to evaluate their practical impact, and gather feedback for further refinement, as part of an initial *Descriptive Study II* in (Blessing & Chakrabarti 2009).

Results

Overview of Collected Data. Data from the case company was divided between three groups. The first two were from junior and senior employees involved in project work, and the last group was from other departments or employees in supporting roles. Project related roles included project managers, project engineers, and automation technicians. Supporting roles, or roles from other departments included subject matter experts, the product manager, HSEQ manager, production lead, and logistics and supply chain personnel. All but one participant was Norwegian. In figures 2 and 3 are excerpts from the data collected, where the first two groups have been compared.

Agreements							
Project Challenges	Communication with customer	Unclear scope	Workload and time	Poor customer documentation			
Daily Challenges	Frequent changes	Workload (multiple projects)	Time spent on 'firefighting'	Work differs from person to person	Interruptions	Time-consuming emails, meetings, and communicating	
Checksheets	Generally positive	Better alignment	Facilitates handovers	Effective if easy to use, concise, clear, self explanatory	Good with reminders on what needs to be done	Potentially cumbersome/ taking up time	Might not be done well enough
Guideline	Neutral/positive	Checksheets were of a higher importance					

Figure 2: Excerpt of Collected Data: Agreements

Knowledge Management Challenges. The interviewees' responses were closely related, and they mentioned challenges in documentation, such as trouble finding required information, knowing if it was up-to-date, and who to ask if something was unclear. All respondents said most of the information were stored on a server, with limited ways of searching for it. They stated that when they found the document they were looking for, they experienced that most of the time it was an outdated version or revision. In some cases, they had to ask around or continue searching, and in other cases, they ended up rewriting the document to make a best effort of getting it up to date. When asked if they shared the document afterwards, they replied that they had considered it, but they were not sure how they could share it or where it should be stored. Some mentioned that documents and templates were stored in a centralised documentation database, and others said they didn't use this database at all because of it being cumbersome or difficult to use. Even here, they claimed that several documents were out of date, and they had to ask around if they wanted to find an up-to-date document, if it even existed. Most participants didn't think too much about this situation, as the office is a close-knit community, and they found it easy to just walk around asking who might know something about the issue they had. Frustration was more present amongst junior employees who might not know what to ask or who to ask, some of which had never been shown these documents or had little to no training in this software tool.

Disagreements			
Available Tools	High seniority: mostly satisfied	Llow seniority: Tools are outdated / cumbersome	Tools a daily challenge for low seniority persons
Quality	Managers: Wishes more quality checks	High seniority: Happy with today's solution	Low seniority: More QA to ensure the correctness of work
Ease of Finding Information	High seniority: Has experience to find what they need	Low seniority: Struggles with finding information	Both groups: Difficult to find up-to-date versions

Figure 3: Excerpt of Collected Data: Disagreements

The sentiment from senior employees was that they perceived the main challenges as, understanding the scope of the project, acquiring and allocating resources, and keeping track of the progress and budget of the project. They also mentioned that time was consumed in meetings and answering emails and had more challenges with the project management part of projects. The junior employees on the other hand mentioned greater struggles with finding information they needed and were more focused on the technical side of the project. Some of the less experienced engineers stated that they had received limited training or introduction, and that they were dependent on older documentation available, and asking other colleagues. When asking others, some respondents said that they didn't always find an answer to what they were looking for, as they didn't know the correct questions to ask. They mentioned that this may be because the other party might have a lot of knowledge and experience in the area and not know exactly what their needs were. In addition, some mentioned that there were no clear guidelines on what should be done and in what order, so some junior employees had realised they were working on a later stage in the project before the previous deliverables were concluded. They claimed that this added to the confusion and resulting in rework.

Existing Tools and Processes. Some gaps and inefficiencies discovered during the interviews and workshops were within the areas of knowledge reuse and quality assurance. Other gaps that were realised was in the way different individuals were working, and the alignment and quality of finished

deliverables where common mistakes and errors were found. During the first workshop, the HSEQ manager discussed how a new initiative should have a quality part to it. He mentioned that this was due to the lack of quality assurance in current tools and practices. In his experience, some projects, because of time constraints and smaller project teams, checking and validation of deliverables were not always done, which could result in avoidable errors. A discussion on the checksheets continued, and it was decided that every checksheet should be checked and signed by a second person. Later in the session, some participants agreed that the checksheets should be connected to different milestones, leading up to a quality gate. Before passing the quality gate, all checksheets were to be completed and signed off. One of the managers stated that quality gates often represent a different stage in the project where the customer is being invoiced, or a larger activity will follow, such as the shipment of equipment. Another topic being discussed was on how to make the guideline and checksheets digital tools. It was a general wish that it would be beneficial to keep the guideline as a digital document, accessible through the company's SharePoint portal. One manager working on improvements and training within the case company informed that there is ongoing work in the company to develop a knowledge page, which writes in detail about different products and software solutions that the company uses. Participants discussed whether the checksheets could be linking to this online database, and that a guideline could be based off this initiative.

Guideline. The general takeaway from the participants was that the guideline would function as the detailed collection of knowledge and information on how to perform certain tasks in detail, and a general guideline on when to complete them. They mentioned that it would also benefit the users if it were serving as a core document that kept track of where to find additional information that may be of use, such as templates, related documents, or tools. One manager said that the guideline should be created with the intention of being a living document that would at the first instance contain the most important knowledge and milestones. Another said that as the tools discussed in this paper were put in use over time, this document could be expanded to incorporate additional information. The goal with this artefact, however, is to serve as an easy-to-use reference database that, if needed, can guide the user to where more information may be found, something all participants wanted.

The product manager stated that an existing effort into developing a project handbook in the case company had previously been done, and that this document should be evaluated when making a new guideline. He said that this handbook was lacking structure and was too comprehensive. It was therefore important to create something that was easy to refer to and use, and that could be kept up to date. In the general discussion, it was decided that the case company's Intranet on SharePoint could be used for this specific purpose. The manager working on improvement and training said that the Intranet is easily accessed by the employees, and due to it being on a digital platform, easier to design for usability and flexibility in representing content. On this platform, a *Knowledge Page* had already been created, and he and another person had started a team to continuously add content over time. During the second workshop, when validating the research, participants were positive to contribute with their feedback to make the process of adding relevant content easier. One participant said that feedback would be reflecting different people's preferences, and this could be reviewed and incorporated to make the guideline as comprehensive as possible, whilst keeping simplicity.

In the workshop it was discussed that the guideline in its digital format would allow employees easy access to main areas of interest, such as software, hardware, and the project process. When entering any of the areas of interest, a new set of topics could be browsed, such as the different software solutions the case company are using. With these topics being named after milestones or keywords, as one participant put it, it is thus making it easier to navigate to the area where they want to explore information. The knowledge and training manager said that at the current time, they are focusing on the software topics, which is their area of expertise, and what most respondents in the workshops requested. He suggested that over time, topics about the project process detailing the typical project timeline with milestones could be added.

Checksheets. Through interviews it was discovered that checklists exist within parts of the case company, although it was not currently existing in the engineering department. One user of these checklists

stated that existing checklists lacked vital information to ensure they were useful and that they were not capturing enough knowledge. Several participants suggested a solution with a new layout and design of the new checksheets. The discussion in the workshop concluded that checksheets need:

- A status field, with options such as “not started”, “completed”, “not complete”, “deferred”, “not applicable”.
- A short description of the activity, such as “data backup”, “software testing”, “on-site”, “office”, etc.
- A short description of the task, explaining the “what”.
- A comment explaining the “how” to perform the task. This should be a short and concise instruction. It will also refer to the guideline for more detailed information.
- A field with more information, explaining the “why”, for example “legal requirement”, with links to relevant information or related documents.
- A date field. This would be the date of completion but could also include a suggested completion date field as well.
- Two sign-off fields. One for the person completing the task, and one for quality control.
- A field showing which quality gate this task relates to or which stage, and any deadline if relevant. This field would be useful for filtering the list.

The development process started after the first workshop, and they were inspired by existing works by Bergsjö et al. (2021) and tailored to the company. In this work checksheets are presented as a lean methodology (originally from Toyota), where engineers used checklist principles but expanded the content to include richer descriptions and instructions for how to assess the consent of each checklist element. It is suggested that a checksheet element not only should contains the “what” (to do) but also “why” and “how” and hence bridging the gap between a simple checklist and an extensive guideline. The product manager suggested that when developing the checksheets, the engineering process as it exists in the case company should be evaluated, with each checksheet being related to a specific milestone. He said several milestones should lead to a quality gate, which will close that stage of the project. It was mentioned that these quality gates typically involve invoicing or other large events of importance, such as shipment of equipment.

After feedback from several participants, particularly the ones being on site regularly, the guidelines should be designed in a digital format so that it is possible to print them on paper if necessary. Other participants said that they should be made in such a way to contain only the minimum required information to make them clear and easy to use. After a discussion about checklists versus checksheets, it was agreed that the idea would be that employees should be able to look at the “what” describing the task and then know what they need to be doing. If they had not been using the checksheet before, the “how” would pinpoint them in the right direction. If they were still requiring more information, the “how” could link to the *Knowledge Page* where more detailed information could be found. This way, the checksheets would cater to both employees of different levels of expertise and experience in using the checksheets. Another participant said that they would for an experienced user serve as a list of reminders, and thus not be seen as overly time-consuming. The idea of it being a list of “friendly reminders” seemed to please most of the participants. The HSEQ manager stated that the “why” would provide context to the task to explain why it is important, such as a class requirement. Another stated that as an addition, it would make it easier to review the specific checksheet item later; for example, any obsolescence would be discovered if the “why” is no longer relevant.

Summary on Findings. Participants were initially introduced to the idea of a guideline and checksheets in the interview phase, which continued in the later workshops. The reactions were mostly positive, with the main concerns being that they were worried it would take up a lot of their time. Some questioned the validity of the QA check. Further in the workshops, topics such as usability and ease of use were brought up as important. If the tool would not interfere with their way of working, they agreed that these tools would be supporting the effectiveness and quality of the project process. An almost unilateral feedback expressed that most participants would be positive to have a guiding tool that would support them throughout the project process. An example of both tools can be found in the appendix A

and B. After discussions in the validation workshop, the artefact that was of the highest interest was the checksheets. They preferred easy access to both the guideline and the checksheets and agreed that keeping the checksheets as simple as possible, whilst supporting them with the guideline, was a good solution.

Analysis and Discussion

Interpretation of Results. Through the collection of results it was discovered that poor knowledge reuse and challenges in finding relevant documentation were the main issues. Because some projects are more complex than others, and because of differences between project managers and project teams, some variance exists between deliverables from project to project.

> RQ1: What specific knowledge management inefficiencies in project documentation and communication hinder project management effectiveness?

It was discovered that lacking knowledge reuse and challenges in finding relevant documentation was the biggest issues encountered by the users. This was a bigger issue amongst employees with less experience, but it also existed amongst more experienced ones. The *Knowledge* Page, as discussed in the *Results* chapter, was a direct answer in trying to solve this challenge. Aspects such as variance in scope and deliverables from project to project also complicated things, as it makes reuse of knowledge more difficult. Overall, a selection of all groups of employees stated that time and resources was a main challenge. It was found that a lot of time was spent on replying to emails, completing customer claims, correcting documents, finding documents, and figuring out exactly what was needed to deliver to the customer. This seems to stem from a lack of guidance in the projects, and some parts of the process seeing less time and effort invested than needed. In many projects the engineering process is started before everyone are certain on what they need to do. Often, questions and clarifications needed about interfacing systems surface, and by that time they often lead to rework. Internal communication, on the contrary, seemed to be seen as excellent by all participants that were asked throughout the process.

Perspectives. Common themes and patterns that emerged from the interviews and workshops included out of date information or documentation, with finding it and knowing where the latest revisions were located being the biggest issues. Difficulties in managing all aspects of project management with current tools were another theme that was more prevalent amongst more experienced project managers and project engineers. Whereas some juniors with larger responsibilities also faced some of these issues, the seniors were more concerned about keeping track of resources, time and costs. The less experienced engineers were mostly concerned with their technical knowledge and finding information and were focusing most of their time on overcoming the technical aspects of the project. They were seeing the technical aspect as the more important one, as it is what is leading to the product that will be delivered to the customer. Having no clear way of sharing knowledge in a good way for further reuse was yet another theme that emerged, which were as prevalent amongst the junior employees as in the more experienced seniors. Some experienced engineers said that they would be happy to share their knowledge and experience, but they were unsure how, and the time was limiting them. This affects less experienced employees, as they lack experience and the tacit knowledge. Senior employees stated that they were happy sharing their knowledge to develop the guideline and checksheets. If they can invest time into developing a tool that many people can use, the result may mean less distractions for them in the future.

> RQ2: How can the development of a tailored guideline and accompanying checklists address these knowledge management inefficiencies and improve project management practices?

By standardising the way of working, and getting feedback from all relevant internal stakeholders, the aim for the guideline and the checksheets are to solve part of the issues in the second research question. A set of best practices can be developed through this guideline, with an easy-to-follow framework simplified by clear and intuitive checksheets, with continuous feedback aiding the development and maintenance of this effort. The tools will give a way for tacit knowledge to, over time, more easily being

absorbed by employees who will have a framework based on other employees' tacit knowledge and experience to follow during the project process. Such new tools could alleviate the current difficulties in managing all the aspects of PM and KM shortfalls. By having linkage between the checksheets and guideline it would be easier to make changes to either of the tools to keep them up to date. Artefacts such as documents and templates often see changes in the case company, and by keeping the references to this information up to date in the tools it will improve the efficiency of retrieving correct knowledge at the right time. By getting feedback from stakeholders, knowledge can be captured better and incorporated into a unified framework that will make knowledge more accessible and easier to reuse.

Implications for Systems Engineering. The new tools may affect engineers mostly in a good way, in terms of giving clear, up to date instructions on what needs to be done at a certain point in the project. A timeline to follow was highly sought-after, especially by the one's with less experience. The wish for the checksheets to incorporate the minimum necessary information to point the user in the right direction could be challenging. Different people may have different perspectives on what is considered good or well-made. One of the biggest drawbacks that several participants mentioned was the required time for using these tools. As they were already busy with a plethora of tasks, the thought of adding yet another component to the equation made some sceptical. Therefore, having long checksheets did not encourage some participants. A counterargument is that the checksheets could be distributed to other team members, and the PM or project engineer would not have to sit with this task all by themselves. The discussion evolved to discuss trade-offs: could we allow employees to make some mistakes in the beginning with the new tools? It can be argued that that would be a better way of working than what is currently practiced in the company. As a starting point, the checksheets should be at a higher level with only the most important information. A higher level checksheet can have a task that states "complete the pre-commissioning checksheet according to procedures", with a link to the relevant information. This way, with a hierarchy of checksheets, one can maintain a leaner approach to the main checksheets, which would be easier for a PM to follow to get a good overview. Lower level checksheets could be distributed as part of a work package to a supporting project member. On the other hand, the guideline will be acting as the 'database' where more comprehensive information and descriptions can be found. Linking the checksheets to the guideline, it will be catering to the needs of engineers with both much and little experience. By developing checksheets related to different milestones, the tool can be handed to different engineers involved in the project. A project member working on the software solution at a certain stage in the process can be handed a lower level checksheet by the project manager, alleviating their workload and facilitating collaboration.

Implications for Management. From the reviewed paper by Didenko and Suarez Pliego (2015), knowledge management is seen as a great responsibility by management. PM in SMEs often lacks formal procedures, and they often rely on oral communication (Didenko & Suarez Pliego 2015). Didenko & Suarez Pliego (2015) also discusses that while tacit knowledge is vital for information, it is often not captured effectively, causing loss of critical insights. As this paper discusses, the same challenges exist in the case company, and managing these processes are time-consuming for managers who often run their own projects to keep the boat afloat. Developing a guideline and checksheets would be seen as a huge task, and realistically, it would need to be considered a collective effort. The process improvement and training manager shifted his focus precisely towards the area of training and processes for this very reason, as well as to alleviate the workload on the other managers.

A heavily discussed topic in the first workshop was the QA aspect of the checksheets. The HSEQ manager said that new checksheets would require two signatures for each completed task. Whilst some agreed, there were a majority that saw this as a requirement that would greatly increase time usage. However, in the interviews, several respondents mentioned that they wanted more QA, as they noticed that it sometimes caused challenges in erroneous documentation, a sentiment shared by the HSEQ manager. One participant stated that he was sceptical to whether this practice would be followed. What if someone signed off tasks, say at the end of every fortnight, to the best of their knowledge, just because they had to do it? Wouldn't that be against its purpose? The HSEQ manager stated that the quality would increase with every signature, and as such it should be implemented. However, it was discovered that the signoffs on documents are already not widely practiced, often having the same engineer

checking their own document. Does it then improve the quality? Would a benefit or a penalty be required for employees to start properly checking their documents? A suggestion could be to either start off the testing period with no signoffs and see if any changes are noticed. Then they could be added later if it was seen as required. It could also be the other way around, removing either one or two signoff fields if it was deemed unnecessary.

Comparing the Theory. Back in the literature review, it was discovered that the focus often is on product organisations and companies working on larger projects spanning greater periods of time. Large corporations such as Toyota are also well covered by this research (Morien 2005; Suh 2017). Such corporations do, however, not compare as well to SMEs working in the maritime field. Organisations in the same industry, but which are of a larger size, is still encountering similar issues when it comes to knowledge management and the sharing of knowledge (Ahmad & Bergsjö 2021). This means that there are still issues for SMEs at different sizes when it comes to PM and KM.

Methodology Discussion. The main methodology in the research centred around the use of interviews and workshops to follow the participants during the different stages of the research process. The qualitative approach allowed for elicitation of feedback and experiences along the way, which was required to be informed of how the different stakeholders in the company were working in projects. Because of a busy schedule, it would have been beneficial to interview more internal stakeholders, and over several iterations. The general feedback started to converge to similar responses towards the end of the interview process, so the data collection from the interviews were deemed satisfactory. The greatest challenge was to gather all respondents for the workshops, as differing time schedules meant that some people could not attend. In a later setting, it would be better to schedule more than one meeting for each workshop to increase the chance of attendance. The process allowed for feedback to be received at different stages in the development process, all while having informal dialogues with colleagues during lunchtime or coffee breaks.

Contributions and Future Research Directions. This research got its inception after a discussion with managers and the researcher's own experiences in the company. Limited research was found from SMEs in the project field, working on mostly small-to-medium projects. It is hoped that this research may contribute by showcasing typical challenges such companies may have, and potential solutions to resolve them. The proposed tools will be tried out in the company following this research and will therefore not be covered in this paper at this time. It would be beneficial with future research in similar SMEs such as the case company, as well as in organisations that run larger projects, and that are in different engineering industries.

Conclusion

Summary of Key Findings. This research has been investigating the inefficiencies relating to project and knowledge management (PM and KM) documentation and communication at a SME in the maritime sector. Examples of the challenges related to documentation, communication, and knowledge sharing, which had differing views and opinions depending on the seniority of the employee being interviewed. The research followed an iterative process involving interviews and workshops for validation purposes. A process of developing a guideline with checksheets tailored to the company were initiated, with positive feedback from the employees. These tools were developed iteratively, tested and implemented to address these challenges. The findings showed that the introduction of structured guidelines and checksheets could potentially provide a significant improvement to the clarity, efficiency, and consistency of PM and KM practices within the case company. One particular case was the stringency of signoffs on checksheets that improved practices without adding to the administrative burden. By standardising the processes and improving documentation flows in the company, the tools are expected to contribute to reducing project delays, lowering costs, and mitigating information loss.

Answering the Research Questions. RQ1 identified specific areas where PM and KM saw inefficiencies, such as in documentation and communication, knowledge sharing, QA, time management, and the existing project process. RQ2 demonstrated how a guideline and checksheets can effectively

address these inefficiencies, by streamlining processes, gathering knowledge, and enhancing communication, in a lean and efficient way suitable for SMEs.

Future Outlook and Recommendations. An initial evaluation was conducted through a validation workshop, and feedback from various stakeholders showed strong interest and belief in the tools' potential impact. The guideline, serving as a central information hub, and the checksheets, offering timely project support, were well received within the case company. Going forward, these tools should be continuously refined to keep pace with technological and regulatory developments. Broader application across SMEs of different sizes and sectors should also be explored. Further research could focus on integrating digital tools to improve data and knowledge sharing, particularly in environments where accessibility and usability are key. Within the case company, regular staff training is recommended to ensure effective use and integration of the tools. A longitudinal study could also evaluate long-term effects on strategic goals, including scalability and adaptability to changing market demands.

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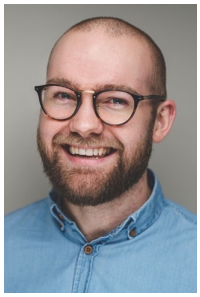
Biography



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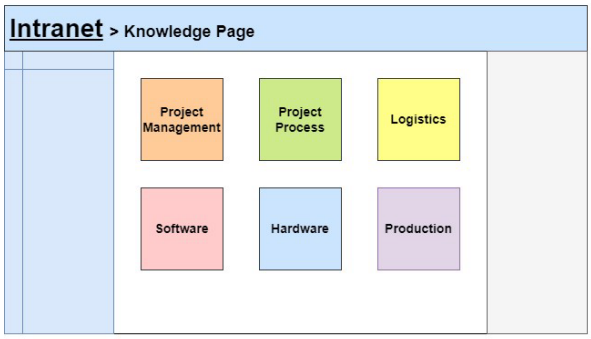
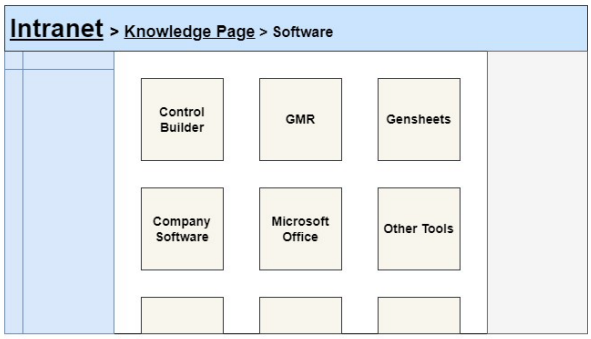
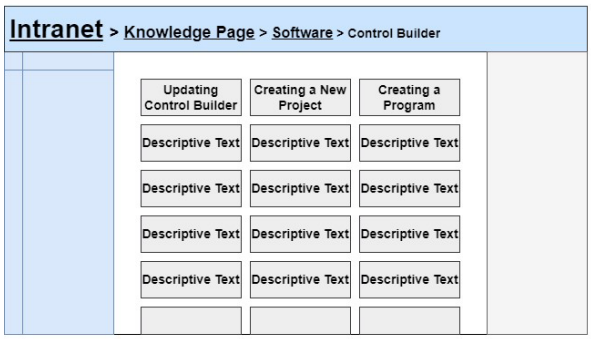
Dag Bergsjö is a professor in Systems Engineering at Chalmers University of Technology as well as working part time at the University of South-Eastern Norway. Dag Bergsjö got his PhD in 2009 and have since performed research relating to complex product development and Systems Engineering predominantly focusing on information management, knowledge management and engineering support systems.

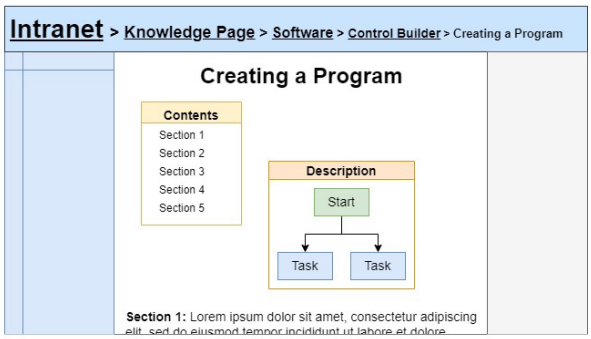
Appendix

A. Guideline Design









B. Checksheet Design

Project Name and Description

Checksheet ID#

Rev. 01

Status	Activity Type	Task - (WHAT)	Instructions - (HOW)	More Information - (WHY)	Comments	Sign.	Initials	Date	Milestone	Quality Gate
Complete	Handover	Handover meeting from Sales	Follow the handover checklist found here according to the procedures	To ensure a proper handover between departments without information loss. Part of the company quality guidelines		Sign.	SSK	01/04/2024	1	1
						QC	MGR	01/04/2024		
In Progress	Hardware	Create Hardware List, Rrder long lead items	Create a first revision of the hardware list and order the most important and basic items (controllers, communication interfaces, minimum required IO, Computers and Monitors, etc.). Refer to the	To ensure the basic hardware is acquired. Price increases for hardware may occur over time	Awaiting feedback available stock	Sign.	SSK	04/04/2024	2	1
						QC				
Deferred	Kick-off	Kick/off meeting with Customer	Gather necessary information (Timeline, scope, new hardware, equipment, interfaces, P&IDs, IO list (if applicable)) See relevant info on the Knowledge Page	To ensure the scope is clearly defined and that responsibilities are clarified	Customer not available before week 16	Sign.	SSK	11/04/2024	3	1
						QC				
In Progress	Documentation Review	Review the provided documentation from the documentation	IO list, P&IDs, system philosophies, interfaces, IO requirements. See more information on the Knowledge Page	Missing or unclear documentation may increase cost and risk in the project, and cause delays. Read more about good documentation	Review started, still waiting for missing P&ID's about *External Supplier's System*	Sign.	SSK	17/04/2024	4	1
						QC				
Deferred	Lab Setup	Set TimeSync for all OS's	Instructions for setup found in C:\Misc\TimeSync, and on the Intranet	To make sure alarms on all OS's are synchronised, and that SPM data export functions correctly	OS21 not available yet	Sign.	XXX	07/05/2024	2	2
						QC				
Not Started	Backup	Backup CB Project folder	First verify that if the Control Builder project can go online. Also check for additional files in Compact Control Builer AC 800M\Libraries Link to guideline section	Internal routines on ensuring quality within our projects (link)		Sign.			6	3
						QC				

C. Interview Questions – PM and Project Members

1. General Questions

1.1. General Challenges: "Can you describe some of the biggest challenges you face in managing projects currently?"

1.2. Daily Operations: "What does a typical day look like for you when managing a project? Are there repeated tasks or issues that tend to consume a lot of your time or attention?"

2. Challenges (Specific)

2.1. Project Management Tools and Methods: "What tools or methods are you currently using for project management? What do you find most effective or least effective about them?"

2.2. Communication and Collaboration: "How do you currently communicate and collaborate with your team and other engineers or project members during projects? What challenges do you experience in this area?"

2.3. Documentation Practices: "Can you walk me through the process of how project documentation is handled? What are the pain points in this process?"

3. Needs / Solutions

3.1. Ideal Features: "If you could create the perfect project management tool or system, what functions, features, and qualities would it include? How would it solve the challenges you've mentioned?"

3.2. Guideline and Checklists: "How familiar are you with the use of guidelines and checklists in project management and projects? Do you think a tailored guideline with associated checklists could improve efficiency in your projects?"

3.3. Perception and Preferences: "How do you see yourself using a guideline and checklists in your daily project management tasks? Are there specific features or elements you think are necessary for these tools to be helpful and easy to use?"

4. Acceptance / Implementation

4.1. Barriers (to Adoption): "What potential challenges do you foresee in implementing new guidelines and checklists for project management and in projects? How might these be solved?"

4.2. Training and Support: "What type of training or support do you think would be necessary for the successful adoption of new guidelines and checklists for project management and in projects?"

5. Feedback / Improvement

5.1. Feedback Mechanism: "How important is it to have a procedure for providing feedback on such a guideline and checklists after their implementation? How do you imagine this process would look like?"

5.2. Continuous Improvement: "In what ways do you think the guideline and checklists should be updated or improved over time based on user feedback and changing project needs?"

6. Any Other Business

6.1. Is there anything else you would like to add?

D. Interview Questions – Other Departments, Supporting Roles

1. **General Questions**

1.1. General Challenges: "Can you describe some of the biggest challenges you see in how projects are managed currently?"

1.2. Daily Operations: "How do projects impact your daily tasks? Are there project-related tasks or issues that significantly affect your work (i.e. consume your time or attention)?"

2. **Challenges (Specific)**

2.1. Project Management Tools and Methods: "How do project management tools and methods influence your role or your work? Are there tools that facilitate or complicate your contribution to projects?"

2.2. Communication and Collaboration: "From your perspective, how effective is thecommunicationd collaboration between the project team and you/your department? What challenges have you noticed?"

2.3. Documentation Practices: "How does project documentation affect your work (directly/indirectly)? Are there challenges in accessing the information you need?"

3. **Needs / Solutions**

3.1. Ideal Features: "Considering your role, what features in a project management tool or system could help streamline your involvement with or support for projects?"

3.2. Guideline and Checklists: "Are you familiar with the use of guidelines and checklists in managing projects? How could having better access to or understanding of these tools make your job easier?"

3.3. Perception and Preferences: "Can you see ways in which a guideline and checklists might be useful for your interactions with project teams? What kind of information or features would be beneficial for you?"

4. **Acceptance / Implementation**

4.1. Barriers (to Adoption): "What challenges do you think might arise if new guidelines and checklists are introduced and used in different parts of the company? How do you think these challenges can be solved?"

4.2. Training and Support: "What kind of information or training would help you/your department better understand and interact with new project guidelines and checklists?"

5. **Feedback / Improvement**

5.1. Feedback Mechanism: "Would you be open to providing feedback on new project guidelines and checklists that indirectly impact your work? What would be an effective way for you to contribute your insights?"

5.2. Potential Enhancements: "Imagine if guidelines and checklists for projects were being developed. What suggestions would you have to ensure they are also beneficial for departments like yours, not just for project teams?"

6. **Any Other Business**

6.1. Is there anything else you would like to add?