VAASAN AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES

Rami Markkula

IMPLEMENTATION OF ENGINEERING PLANNING AND RESOURCE MANAGEMENT TOOL

Case: Wärtsilä Marine Business, FGSS

School of Technology
2019

VAASAN AMMATTIKORKEAKOULU
Kone- ja tuotantotekniikka

TIIVISTELMÄ

Tekijä	Rami Markkula
Opinnäytetyön nimi	Implementation of Engineering Planning and Resource Management Tool
Vuosi	2019
Kieli	englanti
Sivumäärä	52 + 3 liitettä
Ohjaaja	Adebayo Agbejule

Tämän opinnäytetyön tarkoitus oli käyttöönottaa insinöörityön suunnittelu- ja resurssienhallintatyökalu SPEAR Wärtsilä Finland Oy:n Fuel Gas Supply Systems -yksikössä. Opinnäytetyö koostuu prosessien kehittämisen ja käyttöönottoprojektin teoriasta sekä empiirisestä tutkimuksesta.

SPEAR-työkalun käyttöönoton tarkoitus on tehostaa projektien toimittamiseen liittyviä prosesseja. SPEAR-työkalun avulla suunnittelijat ja projekti-insinöörit pystyvät käsitellä ja suunnitella työtehtäviään paremmin. Projektitiimien päälliköt pystyvät ennustaa työmääriä paremmin, arvioida projektiin kuluvaa vaivannäköä ja kehittää prosesseja saaduilla tuloksilla. Projektit koostuvat monista eri prosesseista, jotka sisältävät prosessiin liittyviä toimintoja ja tehtäviä projektin toteuttamiseksi. Prosesseja parannetaan jatkuvasti suoriutuvaksi paremmin projekteissa.

Opinnäytetyössä käytetään laadullisia tutkimusmenetelmiä. Tietoa kerättiin kirjallisuudesta ja haastattelemalla testiryhmiä. Käyttöönotto suoritettiin käyttämällä perinteistä järjestelmän kehittämisen elinkaari -metodia. Empiirinen tutkimus sisältää SPEAR-työkalun tarveanalyysin, suunnittelun, käyttöönoton, testaamisen ja tulosten analysoinnin.

SPEAR-työkalun täytäntöönpano suoritettiin osaston molempien tuotteiden LNGPac- ja GVU-toimitusprojekteille. Työkalu suunniteltiin insinööritehtävien suunnittelun ja projektinhallinnan parantamisen avuksi. Työkalun käyttöönoton vaikutukset mitattiin lyhyellä aikavälillä.

Tämä tutkimus mahdollistaa SPEAR-työkalun käyttöönoton ja kehittämisen onnistuneesti FGSS-yksikössä ja muissa osastoissa heidän vaatimusten mukaisesti. Tutkimuksen avulla suunnittelijat ja projektiinsinöörit pystyvät järjestämään ja suunnittelemaan päivittäisiä työtätehtäviään paremmin. Tutkimus mahdollistaa myös yksittäisen työtehtävän keston mittaamisen.

Avainsanat	Wärtsilä, SPEAR, käyttöönotto, prosessien kehitys, SDLC ja projektisuunnittelu

VAASAN AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES
Kone- ja tuotantotekniikka

ABSTRACT

Author	Rami Markkula
Title	Implementation of Engineering Planning and Resource Management Tool
Year	2019
Language	English
Pages	52 + 3 Appendices
Name of Supervisor	Adebayo Agbejule

The objective of this thesis is to implement an engineering planning and resource management tool SPEAR for engineering planning and project management in Wärtsilä Finland Oy, Fuel Gas Supply Systems department. The thesis consists of the theory of process improvement and implementation project, and empirical case study.

The purpose of SPEAR tool implementation is to improve processes in delivery projects. With the help of the SPEAR tool, design engineers and project engineers can handle and schedule their tasks better. Team leaders can forecast workload, estimate the effort needed for executing the project and improve processes with obtained data. A project consists of many different processes that include related activities or tasks for executing the project. Processes are constantly improved to perform better in projects.

This study uses qualitative research methods. The research sources were collected form literature and interviewing the test groups. The implementation was performed using the System Development Life Cycle method. The empirical case study consists of requirement analysis, system design, implementation, testing, and data analysis of SPEAR tool.

The implementation project is executed for both product lines of department; LNGPac and GVU delivery projects. The tool support is focused for improving engineering planning and project management. The impacts of the tool were measured in a short time frame.

This study helps FGSS and other departments to implement and develop the SPEAR tool successfully to meet their requirements. After this study engineers and project engineers are able to organize and schedule their daily work better. The study enables also the possibility to measure the task durations.

Keywords	Wärtsilä, SPEAR, implementation, process improvement, SDLC and, project planning

CONTENTS

LIST OF FIGURES AND TABLES

LIST OF APPENDICES

Appendix 1. and Appendix 3. are not published because of business secrets.

GLOSSARY

SPEAR	Engineering planning and resource management tool
FGSS	Fuel Gas Supply Systems, department in Wärtsilä Marine Business
LNG	Liquefied Natural Gas
LNGPac	Fuel Storage and processing system for Liquified Natural Gas
GVU	Gas Valve Unit
ED	Enclosed Design
OD	Open Design
CIM	Continuous Improvement Management
SDLC	System Development Life Cycle
ERP	Enterprise Resource Planning systems
PERT	Project Evaluation and Review Technique
CATS	Cross Application Time Sheet
IPI	Installation Planning Instructions
DDS	Document Delivery Schedule
EXW	Ex Works, international trade term by which a seller makes the product available at a designated location.
Task	Task is a single work with a start and end day and a responsible person. Tasks can belong to one or more projects.

1 INTRODUCTION

1.1 Background

This thesis is made for Wärtsilä Marine Business, Fuel Gas Supply Systems (FGSS) department. Wärtsilä Fuel Gas Supply System business is growing and thereby also the amount of work and the need for better work planning. Previously FGSS project work handling have been managed with only planning tasks for individual projects but now when the volumes have increased and will further increase, project engineers and design engineers are in practice involved in many different projects simultaneously. Constant product development, changing customer needs and customized projects causes the need of updating the task handling to get a better overview of the engineering planning and resource management.

Without a proper tool for planning the work tasks in the project portfolio, people are lacking the overview, that is needed for putting the different tasks into correct priority order. This might cause unexpected scope creep in delivery projects. These challenges in engineering scheduling and project related document delivery causes poor change control and lack of proper initial identification of what is required of the project objectives.

1.2 Objective and Research Question

Wärtsilä FGSS are in process of implementing an engineering planning and resource management tool SPEAR especially for engineering work planning for the LNGPac and GVU delivery projects but also for the Project Management tasks in GVU delivery projects. The SPEAR tool is an internally developed tool for engineering tasks planning and the tool has been in use for many years in another department in Wärtsilä Ship Power. Every department has their own ways of working and a completely different set of tasks to be done. This thesis comprises development, implementation and testing of the SPEAR tool according to the FGSS customized requirements.

The objectives of this thesis are to actively identify and develop the engineering planning inputs for the project delivery tasks and milestones, learn the features of the tool, evaluate the benefits the FGSS could gain, plan the implementation, train the users and support them to take the tool into use. The objective is to have the tool fully implemented and benefits recorded as an output of this thesis. This leads to the following research question:

How to implement the engineering planning and resource management tool SPEAR in engineering planning and project management in Fuel Gas Supply Systems?

1.3 Outline of the Study

This thesis approaches the research question by introducing the subject theoretically and reflecting the theory to an empirical case study. Second chapter explains the research method and the reasoning behind the research design, data collection and analysis, and reliability and validity chosen for this study.

The case company is presented in Chapter 3. This chapter will give a compact overview of Wärtsilä Oyj and the department where the study is made.

The fourth chapter presents the theoretical part of the study that gives base knowledge about project process management, process improvement, system implementation projects, SPEAR & ERP tools, and project planning to provide deeper insight into the subject matter of the case study.

The case study is presented in Chapter 5. The case study will introduce the starting point, completing the case study, analyzing the collected data and impact of the study. After the case study the suggestion for further research and predictions follows.

Chapter 6 presents the conclusion and limitations of the whole thesis review and how the implementation has affected the problem from the starting point.

2 RESEARCH METHOD

The Research methods of this thesis was empirical qualitative approach. This approach is used in understanding complex issues, by determining and defining the research question. This thesis consists of a theoretical part and a case study. Therefore, the thesis has a qualitative approach of both empirical and theoretical study.

The case study relies on the qualitative data collection and is arranged by interviewing method in meetings arranged with focus groups and observing the work at the case company. The focus groups are gathered from the FGSS management team and engineering team that consists of employees that have the most experience and tacit knowledge about delivery projects. Several meeting interviews with the management team and engineering team were carried out to gain an understanding of FGSS business processes, activities and tasks, and tool requirements and needs.

This section also explains the reasoning behind the research design, data collection and analysis and reliability and validity chosen for this study.

2.1 Research Design

The research was carried out first by interviews and later presentations. These interviews were selected to obtain a good overview of the employee's perspective to the implementation project. The discussions were used to evaluate and analyse the interviews findings. The engineering team interviews were divided to smaller group interviews according to their engineering field because of the availability issues. The engineering fields were divided to mechanical, electrical and automation and process engineering groups with the longest experience and tacit knowledge. Most experienced project engineers were interviewed individually. The management team was interviewed mostly as a one big group that included resource manager, engineering manager, project management manager, operational manager, project controller and document controller, SPEAR expert and thesis mentor. The research design of this thesis is divided to pre-production, research work, production and post-production. This research design is shown in Figure 1.

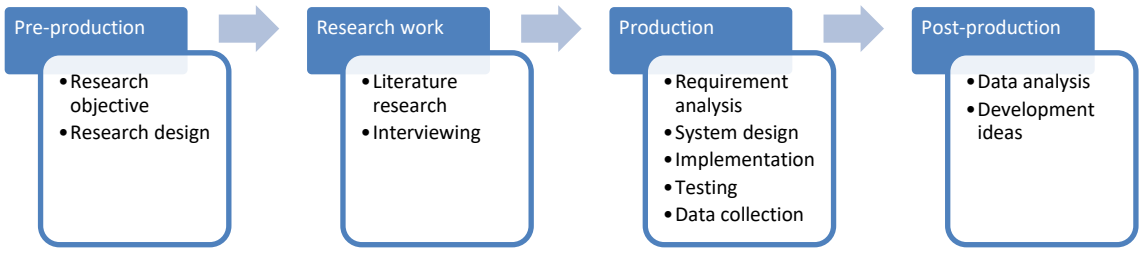


Figure 1. Research design

The pre-production phase focuses on finding the research problem and finding the correct approach for the study. In addition, the research design is developed for a better study follow-up.

The literature research focuses on practices in process improvement and system implementation to build a solid theoretical base knowledge for the problem at hand. The sources that were used in literature research were mainly obtained from the Tritonia library, teacher's materials and the Finna electronic databases. Interviewing research work will be performed by arranging meetings with engineering, project management and document control lines.

In the production phase the research work findings are put into practice in the case study. The requirement analysis solves the problems in the starting point of case study. The processes will be redesigned and the system designed. The results will be presented to management team and further processed. The implementation and testing phase will be executed by training the users, defining the test delivery projects, supporting the test group and collecting the data.

In post-production the data collected from the production phase will be analyzed for identifying the benefits, and disadvantages of SPEAR and defining development ideas for the further development.

2.2 Data Collection and Analysis

The data collection of this thesis was carried out by interviewing focus groups in the case company and founders of SPEAR tool. The interviews were carried out in different styles and different dates depending of the participants' availability. The interviewing styles can

be divided into formal meetings and informal meetings with a more conversational approach. The methods for interviewing were Skype meetings and face-to-face meetings and a mix of both methods. The interviews were very different depending which focus group was interviewed. The interviews were performed for both individual participants and groups to get individual opinions and group acceptance. Appendix 1 presents the details of the interviews. Data was collected into meeting memos and new ideas were presented in the following meeting.

The interviewing topics were different between the engineering team and the management team. The design engineering team and project engineers were interviewed to gather updated information about their individual tasks and responsibilities. The management team meeting interviews were more about presenting and approving the outcome how the case company is going to use the tool. These meetings included proposals of changing the ways of working so the approval of the management team was mandatory. These meetings are needed for making sure that the tool will be used and tested, and to make sure that it will meet the requirements.

The data collected from the testing was used for analysing the impacts of the SPEAR implementation and improving the tool in further development. The data was collected with follow-up meetings where users could give feedback about the tool. The meetings followed the review questions concerning the user experience.

2.3 Reliability and Validity

This thesis ensures validity by choosing the correct research method for the study. The research interviews styles are chosen to fit best the interviewing event. The language of the interviews is chosen so that everyone can understands what is researched. The style and language is chosen according to what is the most natural way of communicating.

The theoretical research is mainly using scholarly literature to ensure reliability. The case study follows the researched system implementation method. The reliability of the research interviews are ensured by having a lot of meetings with study participants and ensuring that everyone shares the same mindset of the objective of the study. The data collection interviews for test groups will be repeated twice to ensure that the reliability of data.

3 WÄRTSILÄ OYJ ABP

Wärtsilä is a Finnish corporation which manufactures and services power sources and other equipment. Wärtsilä is a global leader in smart technologies and complete lifecycle solutions for the marine and energy markets. Wärtsilä is focusing on environmental and economic performance by highlighting sustainable development, efficiency and data analytics. Wärtsilä is divided to three main business lines; Energy Solutions, Marine Solutions and Services. In the start of 2019 Wärtsilä released a new organization model where Wärtsilä Services are integrated to two other business lines that are named to Energy Business and Marine Business. /1/

Wärtsilä is a listed company that is listed on Nadaq Helsinki. In the mid of 2018 Wärtsilä had approximately 19,000 employees in more than 200 locations. Wärtsilä has operation in more than 80 countries around the world. The net sales are totaled approximately EUR 5.1 billion. /1/ The key figures of 2018 can be seen in the Table 1. /2/

Table 1. Wärtsilä Key figures of 2018 /2/

MEUR	2018	10-12/2018	7-9/2018	4-6/2018	1-3/2018
Net sales	5 174	1 532	1 330	1 246	1 066
Services	2 426	737	572	582	535
Energy Solutions	1 517	431	451	368	267
Marine Solutions	1 232	364	307	296	264
Depreciation, amortisation and impairment	-130	-37	-31	-31	-30
Comparable operating result[1]	577	226	141	123	88
Comparable operating result[1], %	11.2	14.7	10.6	9.8	8.3
Profit before taxes	502	194	130	102	76
Earnings per share, EUR[2]	0.65	0.25	0.17	0.13	0.10
Order intake	6 307	1 874	1 372	1 553	1 507

3.1 Energy Business

Wärtsilä is a significant supplier for power plants and energy storage systems market. Wärtsilä supplies sustainable development friendly and flexible solutions for diesel engine powered powerplants, energy storage systems and emergency diesel generators. Wärtsilä is looking forward to more environmentally friendly solutions with LNG-terminals and solar power plants. The total installed capacity of Wärtsilä Energy Business globally was approximately 67GW in the end of 2017. /2/

3.2 Marine Business

Wärtsilä is a globally leading provider of marine engine, propulsion and manoeuvring solutions to all types of ships and offshore applications. Wärtsilä Marine Business provides, sustainable, efficient and flexible solutions and support for customers of marine business in both oil and gas industry. Wärtsilä is highly rated, customer-oriented business line that customizes the products to fit to customer needs. /2/

3.3 Services

Wärtsilä services are integrated into Marine and Energy Businesses. Wärtsilä Services provides full lifecycle service for over 12,000 customers in over 160 locations globally. Services supports the customers to optimize the performance and efficiency of Wärtsilä supplied products in both Marine and Energy Businesses. Wärtsilä Services are engaged for high quality and comprehensive services, spare parts, maintenance and customer service in all provided solutions. Wärtsilä also provides maintenances for other brand supplied products and solutions to achieve large scale customer support. /2/

3.4 Fuel Gas Supply Systems

Fuel Gas Supply Systems (FGSS) is a specialized team within the Marine Business Flow & Gas Business Line developing, selling and delivering cost efficient LNG storage and process systems (LNGPac™) and Gas Valve Units (GVU) for dual fuel or gas engines. FGSS products are also designed to be an integrated part of Marine Business' offering. The objective is to provide the most reliable and advanced LNG solutions helping customers to meet strict environmental requirements while realizing economical benefits from the lower cost of gas. /3/

3.4.1 LNGPac™

Wärtsilä LNGPac™ is a complete fuel gas handling system for LNG fueled ships and includes the bunkering station, LNG tank and related process equipment as well as the control and monitoring system. A fully described LNGPac system can be seen in Figure 3.

The standard Wärtsilä LNGPac™ uses an IMO type C LNG storage tank. Bunkering takes place from the bunkering station to the LNG tank via an insulated pipe. The tank

connection space contains all necessary process equipment and can be either mounted to directly to the LNG tank in double wall vacuum insulated tanks or placed remotely from the LNG tank in single shell polyurethane insulated tanks.

The LNGPac gas supply system can be customized to the needs of each project on a case to case basis by delivery project team. LNGPac delivery projects can conduct dedicated engineering at the beginning of the project to match the specific operational requirements, safety regulations, and the rules of each classification society. /4, 5/

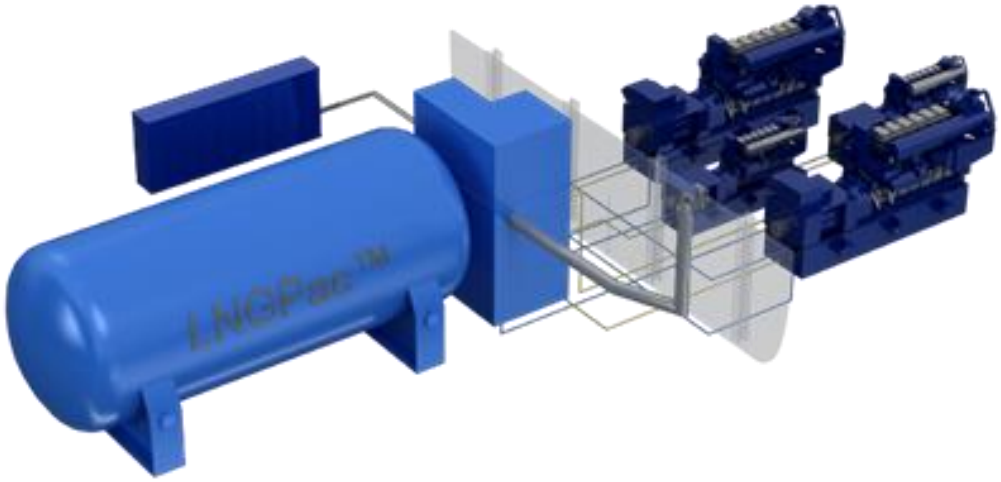


Figure 2. Described LNGPac^{TM} System /4/

3.4.2 Gas Valve Unit (GVU™)

The Gas Valve Unit (GVU) is a module connected to the Duel-Fuel engine gas supply piping. Each engine has its own dedicated GVU. The unit controls the gas pressure to the engine according the engine load.

The Wärtsilä has two alternative solutions for GVU. GVU-ED™ (enclosed design) is a solution where all gas related equipment is mounted inside a gas tight enclosure. A picture of GVU enclosed design can be seen in Figure 4. GVU- OD™ (Open design) is solution where the GVUs are located inside a dedicated GVU room in a hazardous area. /6/

Figure 3. Described GVU-ED™ System /6/

4 PROCESS IMPROVEMENT AND IMPLEMENTATION PROJECT

This chapter focuses on explaining the theory behind project process management, process improvement, system implementation projects, SPEAR & ERP tools, and project planning to provide a deeper insight into the subject matter of the case study.

4.1 Project Processes

A project consists of many different processes that include process related activities or tasks for executing the project. Any development or change in project can be identified as a process. The process is a set of interrelated activities or events that require resources to implement. Processes vary in different organizations depending of the strategy. Processes are constantly improved to for performing better in projects. /7/

The purpose of the process is to process inputs into outputs. Inputs are information, activity, or material that is transformed into output in the process. An engineering task in a project is case related, structured engineering activities or tasks. The output of the engineering task is a specific service or product. Process related activities or tasks need to be structured for executing the project. A standardized way of process activities enables more efficient projects executing. Standardized processes are easier to improve. /7/

4.2 Process Improvement in Projects

Processes are improved in projects for better performance. Process improvement spans all industries. With continuous process improvement management, the company can create a learning organization environment. Successful process improvement requires good change management and mitigating resistance to change into a new innovative environment. Continuous process improvement results in a competitive advantage: the ability to develop faster than your competitors. When the employees of an organization get involved in process management, they work together and make the organization better and more profitable. Using the knowledge of the full organization affects how effective the changes are. The benefits of process improvements in projects are: improvements in project quality, increase in project value, better customer satisfaction, improvement in productivity, improved efficiency and effectiveness, and facilitation of better communication among project stakeholders. /7/

The most important tasks of researching the established “as-is” process are the structuring the process work, the preparation of process diagrams and descriptions, and the assessment of process performance. Acquiring a clear definition of the “as-is” processes is necessary in order develop an understanding about how the process may be reengineered to improve the project process. Researching provides basic information on how the "to-be" process is developed. /7/

There are several different approaches for process improvement, all of which have their own characteristics, although they are otherwise similar. Approaches and models can be found in integrated philosophies and techniques such as total Continuous Improvement Management (CIM), continuous quality improvement, and Six Sigma. Computer-related system projects use traditional and iterative Systems Development Life Cycle (SDLC), Spiral, Unified Process, and agile methods that include Scrum and XP. All the different approaches are shared by modeling, measuring, analyzing and piloting processes. /7/

4.3 System Implementation Project

This thesis will focus on the Systems Development Life Cycle (SDLC) concept. Systems development life cycle (SDLC) is a process model used in the development of software systems. Its basic structure includes six phases from requirement analysis to maintenance. These steps form a continuous thread between themselves, so that after the evaluation, the system will again need to be upgraded and the cycle starts from the start. Although there are many different variations of SDLC, the process still has the same basic structure. The most typical variation is the waterfall model, where each phase is completed in its entirety until moving on to the next /8, 18/. This System implementation process consist of six different phases; Requirement analysis, System Design, Implementation, Testing, Deployment, and Maintenance. Figure 5 illustrates this SDLC waterfall implementation method. /9/

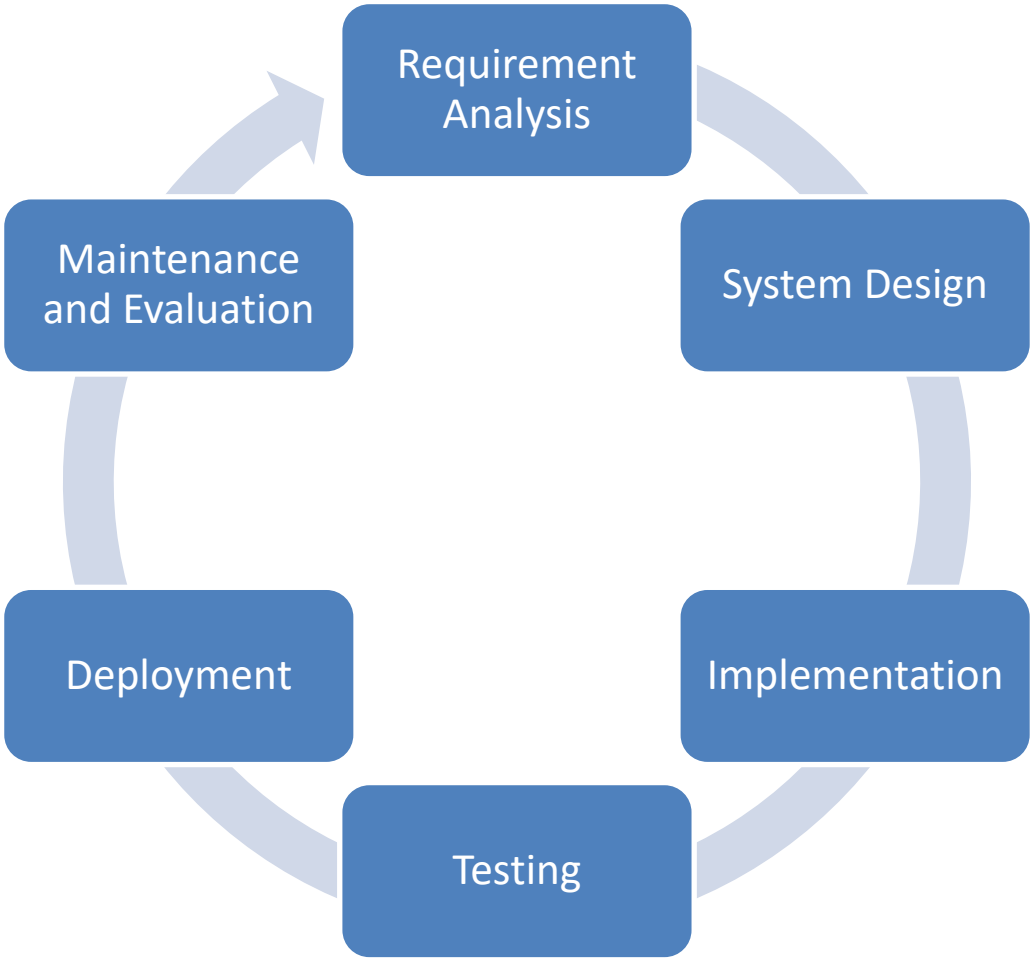


Figure 4. SDLC waterfall model /9/

Benefits of the SDLC are that it is easy to understand and implement with well-defined phases and their sub-steps so that the tasks do not expand insurmountably large. Well-defined phases make it easy for project managers to control and manage projects. Different methodologies provide good support for system implementation project execution, as they take into account the importance of documentation, good planning, user training, and various tools to facilitate the project /8/. The SDLC is proven to work well with large, complex projects as well as small projects. The system works well with global and virtual teams and the projects can be handled with changes in human resources. /7/

Weaknesses in SDLC include that it is not possible to revisit or revise any prior phase once it is completed. In the waterfall model where each phase is completed until moving on to the next, it may become tough to integrate all aspects of project. Changes in SDLC implementation project mean increased development time and costs. /8/ Causes inside

implementation project that expose to risks are management difficulties, lack of documentation, inflexibility, user dissatisfaction, unfinished systems, and high maintenance workload. /7/

4.3.1 Phases in Implementation Project

After the decision of the implementation process the first phase of the implementation project is the requirement analysis. This analysis solves what are the "as-is" and "to-be" portions of the implementation system process and develop the scope according to the boundaries and requirements of the company. This should describe the areas that are expected to improve with system implementation project. /7/

The final output of analysis should describe:

- How the system will work
- How the system will interact
- How all system components are interdependent
- How and what data, information, and knowledge are collected for the system
- How those elements work with the proposed system and
- How various processes will work in the proposed system

In this phase company needs to decide if the current processes are needed to be refined of replaced entirely with new system. Depending on if the implementation is provided by internal or external resources the company needs to solve the budget and time that will be spent in the implementation project and how it affects other processes simultaneously. Solving the affect for other existing processes is done to find required redesigning, caused by new system implementation. To archive successful implementation there must be a plan for analysing all changes that the implementation will bring, and how to handle those. /7, 10/

After the requirement analysis, the system design and development phase begins. In this phase, the data for the system is collected and the system interaction and functions are designed according to the company requirements. The effect and required customisation for the other existing processes caused by the new system implementation is researched. The old processes are modified to adapt the new system. All data is transferred to the new system simultaneously, which can be a difficult task depending on the previously used

methods. After the system is developed, it must be dummy tested. Usually the personnel responsible for the implementation project performs the testing themselves. The principle of testing is to find possible system failures, and how well the various processes will work in the proposed system. /7/

The system implementations phase is scheduled when the development team is confident in and comfortable with both the functionality and quality of the newly developed system. In the implementation phase, the system is introduced to the test group for further testing in the production environment. The introduction includes user group training for independent system usage. /11/

The fourth phase of this implementation is testing the system in the production environment. The testing is performed to ensure the adequacy of the system for the company's requirements. In this phase the benefits and necessity of the existing data is verified. Found incompatibilities require modifications in the system. Big modifications or changing the requirements cause high costs and time losses and complicates the updating of the system. Adding new processes usually require modifications and big changes in the working principle. The testing phase includes active clerical support and collecting the feedback from the testing group. When feedback and improvement ideas are collected, the fixes are made, and the system is updated regularly according to the found problems. The testing phase needs to be completed carefully in order for the deployment stage to run as smoothly as possible. /11/

After the system acceptance of the system the planning of the deployment starts. In this phase the system is introduced to all users. The accepted system includes user training, deployment scheduling and other required activities. The challenge is to change from the old systems to the new without causing unnecessary harm and interruption to the company's processes or to the employee's work. To control the challenges the user training needs to be comprehensive enough for the employees to adopt the new system quickly. The employees need to understand the general idea why the company is transitioning to the new system and the overview of the system logic and potential benefits for their own work. Time spent for the deployment affects the success of the implementation project. Training is often expensive and takes employees' working time. The transition to the new system can be made in steps or move directly to the new system. The company can decide to use also the old methods besides the new system. /11/

Further modifications may still be needed at the deployment stage according to the users' feedback and improvement suggestions. The objectives of the project should be revised, and the measurable objectives should be measured when the system is fully deployed in the business. The completed deployment of the system is by no means the end of the system implementation project. /11/

When the system is fully deployed, the maintenance phase starts, where the company focuses on operating the new system to ensure that the data is up-to-date, and it continues to function properly. The staff or key user group can be hired or selected for the maintenance purpose. The maintenance group continues the system training as well as supporting the usage in order to make necessary changes and upgrades when needed. /10/ System maintenance plays an important role from the time the implementation group signs off on the system. Furthermore, the system requirements may change after the implementation or generate new process improvement, and SDLC starts all over again. /7/

4.3.2 Risks in Implementation Project

Some potential risks can be threat for implementation process, which need to be identified and understood. Risks need to be monitored, controlled, and managed with risk mitigation techniques. These risks can be divided to four categories; technology, organization, people and project size. /12/

The technology risks are related to how well the new system fits to the company's current processes and environment. The new system might not be suitable for requirements. Technology risks include the required information systems and technology for maintaining the new system. Also training the users to the system is a technology risk because proper training is needed for the system to be used as designed. Without internal expertise, the company cannot achieve expected results from the system. /12/

The organization risks come from the company's processes and organizational factors. An organization risk covers possible incompatibilities between the system and the current business processes. Redesigning is modifying either business processes to fit the system or modifying the system to fit the company's processes. These modifications can affect the stability of the system, which makes further improvements difficult. The less changes needed to be made, the lower the risk for implementation project to failure. /12/

People and especially users cause its own risk in implementation projects. Too narrow or unorganized training for the system can cause confusion among employees. Participants needs to be committed to the implementation project to avoid failure. “Fostering an environment that wins the commitment of employees to continuous improvement also lays the foundation for successful implementation”. /13/ The attitude of top management especially for the implementation project is important; otherwise it can cause process failure. This requires firms to change their philosophy form, managing by a commitment to continuous improvement. /12, 13/

Participants falsely believing that the implementation project is completed after the new system has been deployed creates a risk. Employees cannot trust the new system too much to do everything with it. The system must be considered as a guideline for work. /12/

The project size can cause its own risks. Implementing a new system is an important and time taking process for the company. The project that takes time needs the management’s support to be active for effective communication inside the implementation process in order to be successful. The project size can expand due to the company’s changes or additions to requirements. Taking too big a bite at first causes more designing and a more complex system. That can expand the time and budget of the project. With too complex a system or too many decision-makers comes more variables that can predispose for more failures. /12/

4.3.3 Controlling the Risks

The company can mitigate the risks in system implementation projects with different strategies. By controlling the risks, the company will reduce the risk of failure in implementation project. The risk mitigation strategies can be divided to all mentioned four risks. The company should focus on the risks that affect the process the most. /12/

In case of a technology risk the company must decide the requirements that are needed for the new system. After that, the company must choose the best system that fits their requirements. The company should also pay attention to the system support and training. Training must be comprehensive. All the system users need to be informed about the impact of the system on their own work in a big picture. With more awareness about the benefits, the employees can internalize the training better. /12/

An organization risk can be controlled by redesigning the business processes or the system itself to fit the company's processes. The implementation team and management team need to discuss the most suitable way of approaching the risk and stick with it. By redesigning the business processes, the company can receive even more benefits when the data is updated. Redesigning the business processes the company engages to Continuous Improvement Management (CIM). With redesigning the system, these benefits might not be achieved. /12/

People-related risks can be mitigated by investing to a proper training and changing people's opinion about continuous improvement. Training needs to focus on business processes and not only for usage of the new system. Employees must understand the impact their behavior has on continuous improvement, and the rewards they receive for continuous improvement. Understanding the reason behind the implementation process facilitates the transition to the new implemented system. The management's commitment to the implementation process is important for building developing a corporate culture to deal with resistance to change. The seven C's model can be used to mitigate people-related risks and building a developing corporate culture. The seven C's are; Culture, Champion, Change process, Commitment, Compensation, Controls, and Continuous education. Figure 6 shows how the seven C's model is built. /13/

Figure 5. Seven Cs model /13/

Controlling the project size risk requires involving the top management and other members into the implementation process intimately. Involving the project participants ensure that the communication inside the time taking implementation process is successful. Clear roles and management inside the process ensure that the time and budget does not expand. Greatest benefits can be achieved when the project participants and implementation team share the same mindset, what data will be included and what will be the outcome. /12/

4.4 ERP tools & SPEAR

The Enterprise Resource Planning (ERP) systems are business tools that allow companies to automate business processes, share data and practices across the enterprise, and produce and access real-time information. /12/

There are numerous ERP tools and biggest of them are Primavera, Zoho Projects, FasTrack, Microsoft Project and SAP PS. /7/ None of these tools has not yet proved suitable for Wärtsilä Marine Business demands.

SPEAR was selected as a tool because the SPEAR tool is developed and maintained by Wärtsilä internally. The tool is developed especially for resource management and engineering planning purposes. The SPEAR tool is license free and has already found benefits in other departments. Suitability as an engineering planning and resources management tool is already tested and proven. /14/

SPEAR is an engineering planning and resource management tool for engineering time management (tasks are planned for installations, projects and systems, and assigned for Engineers), engineering capacity planning (daily capacity hours are defined per engineer), and for reporting (utilization and availability of resources on individual and department level, workload reports, task reports per installation, project and system). An example of how different entities relate to each other can be seen in Figure 7. The SPEAR tool has been developed especially for the Marine Business customer delivery projects but can be used also for other project types. Improved capacity planning and scheduling of the work are the main benefits the SPEAR tool brings. It is also easier for engineers to organize and follow-up their daily work by using the application. /14/

More efficient SPEAR is developed:

- to review resource availability
- to follow up and balance workload
- to create and track own tasks
- to follow up progress of the tasks. /14/

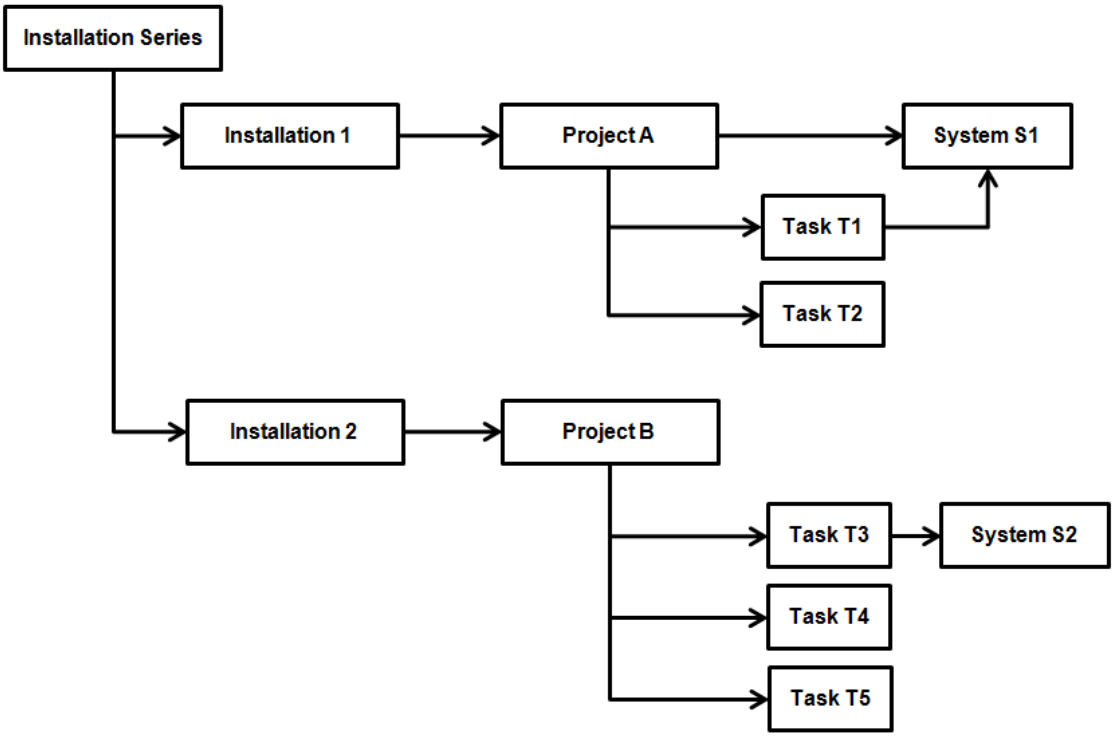


Figure 6. Example of how different entities relate to each other /14/

SPEAR can be used for hour booking, and hours will be registered on a task level. All engineering and other work hours are registered in SPEAR. From SPEAR, hours on tasks can be posted to SAP-CAT. /14/

Team Leaders are able to view, manage and control the available capacity of their resources. For each team member the schedulable and total capacity can be entered. The schedulable capacity means the number of hours per day that can be scheduled for project work. /14/

4.4.1 Benefits of SPEAR

Engineers are able to organize and schedule their daily work better. Maintaining the task list about their work in common application makes an overview of the tasks manageable. Reporting project hours for CATS reporting is easier and faster when the same application can be used for planning and reporting. SPEAR gives engineers a better insight in collaborative engineering functions. /14/

The engineering management is able to have instant and accurate workload reports from the engineers using the different reporting possibilities. Capacity planning improves when engineering workload for the whole team can be seen and compared with reporting tools. Progress follow-up improves when the tasks can be followed better. The management can see if some engineering tasks are late or overdue. /14/

Project managers and project engineers have the status overview of engineering tasks for projects which helps following-up the progress. The project management sees the time schedule for each engineering task and if they are on time. The project management has the list of deliverables for better document handling. /14/

4.4.2 Disadvantages of SPEAR

There is no earlier experience of using SPEAR for work planning in FGSS. Because of the SPEAR is internally developed and maintained there is a limited number of employees to offer technical support. The SPEAR tool is developed for more standardized projects, so the implementation of complex customer tailored projects can make it difficult to work without problems. There is just a limited amount of information about all the tool possibilities. The SPEAR can be used only as a guideline for engineering planning.

The work flow can be disturbed caused by the transition to new software and a new way of working and new habits. Time needed to learn how to use the tool efficiently will slow down the working processes at the beginning. The transition to a new way of working can feel frustrating and complex, which makes it hard to get the best out of the SPEAR. SPEAR used as additional software besides old methods can be found useless.

4.5 Planning in Projects

Planning is estimating the performance of project teams. Planning helps team leaders to forecast the effort towards achieving the project objectives. Milestones must be set and concretized with functional managers and upper management. The planning should include planning the activities to meet the customer expectations and scope. These activities should be measured to meet the milestone deadlines. Possible unanticipated changes or activities in scope should be taken into account when planning, including all the project participant activities that can affect the original plan. The plan should be followed strictly,

but still, if necessary this kind of project planning needs to be revisited and modified throughout the execution of the project. /7/

4.5.1 Project Human Resource Planning

In order to achieve a successful project execution, resource plan needs to be prepared and an organizational structure needs to be selected and formed along with needed resources. The planning out of the resources is used to execute the project and managing the project team. Preparing a successful resource plan, the following four steps should be handled: list the required resources, quantify the required resources, construct a resource schedule, and level the resources. Each project task requires particular skills or knowledge. Based on this information resources can be identified and listed. /7/

Resource leveling needs to be accomplished when there are large or many projects ongoing simultaneously. Too many simultaneous tasks cause over-allocations and that way unequal workload and slack in task durations. Over-allocation can be controlled by delaying or splitting tasks or increasing project resources. /7/

The lack of resources can be a constraint on the completion of a project. Utilizing resources wisely is critical for a project manager. Every employee's personal skills and experience should be taken into account when planning the project resource plan. Maximizing the use of available resources and minimizing the project duration creates an efficient schedule. /7/

4.5.2 Scheduling

A project schedule is the delivery of a project scope. Scheduling is a plan to implement a project using an ordered sequence of activities with time allotted for each activity. The main questions that effective project schedule is to answer are following;

- What activities will be accomplished?
- What is the sequence of those activities?
- When will those activities be accomplished?
- Who will accomplish those activities? /7/

Planning a project schedule and maintaining it is a very important part of project management. It is even considered to be more important than keeping up with the budget.

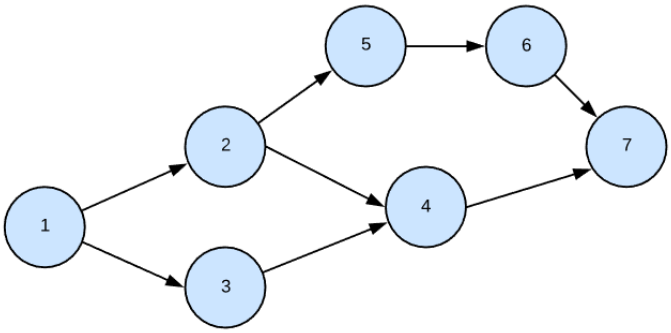
Compliance with deadlines and maintaining the schedule is also important because it can prevent the domino effect. The schedule may delay because of a very small work task. If it is not possible to move forward in other activities of the project, it can be a very significant issue over time.

The activities in a project are networked during the scheduling. The network provides many benefits in a project. Networking should include following matters:

- An estimate of project completion time;
- An overview of how resources will be utilized in the project;
- All activities that are necessary in order to meet the schedule;
- A graphical representation of work to be performed;
- The progress that can be used to track the project;
- An estimate of time and cost at any point of a project;
- The start and end times of all activities in a project;
- All resource conflicts and which activities will need to be coordinated in order to avoid such conflicts;
- The interdependence of the activities of a project;
- The activities that need to be implemented at the same time; and
- Project milestones. /7/

Many tools and methods have been developed to assist scheduling. The most common project management tools are PERT and Gantt chart method.

PERT (Program Evaluation and Review Technique) is a method that allows you to plan and schedule a complex project in circumstances where it is not possible to precisely estimate the time spent on individual project tasks. A simple PERT diagram includes various boxes that are connected to each other by the direction arrows. The boxes contain project tasks, durations and task dependencies that show what happens next in the project after a specific box, i.e. phase of the project /15/ An example of a simple PERT diagram can be seen in Figure 8. The earliest start time of a task is the earliest finish date of a predecessor. The earliest finish time is the total of the earliest start time and the task. Some of the tasks can be done simultaneously, some tasks are in series. /7/



Activity	Duration (weeks)	Immediate Predecessor Activities
1	2.5	-
2	3	1
3	1	1
4	2	2, 3
5	.5	2
6	1.5	5
7	4	4, 6

Figure 7. Simple PERT diagram /16/

On the Gantt chart, the project tasks are listed on the left and the task bars on the right side describe the task duration. For each task, a bar is drawn to describe the duration of the task from the start time to the finish time. By placing this data in the chart for each task bar, the chart shows the workload and time required, and the execution time of each task in the project. It is easy to figure out the order, how the steps are carried out with the help of the bars placed on the chart: some task may last for the entire time allocated to the project, while the second task cannot be started until another stage is completed. /15/. A simple Gantt chart can be seen in Figure 9.

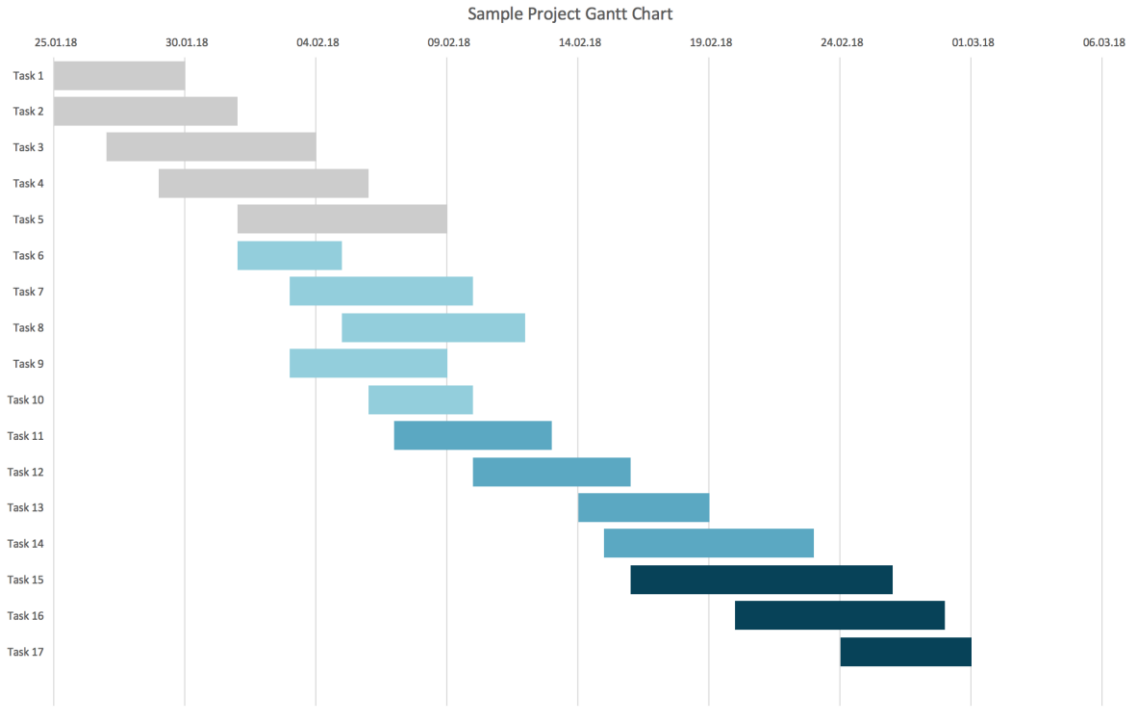


Figure 8. Simple Gantt chart /17/

These scheduling tools and methods cannot be trusted completely. Many factors can cause failure in these scheduling methods. A negative slack can occur due to:

- Unrealistic schedule due to either customer requests or poor planning;
- Very optimistic schedule due to either customer requests or poor planning;
- Some activities slipped during project execution;
- Resources were either incorrect or did not do their job right; and
- Unavailability of resources. /8/

5 EMPIRICAL CASE STUDY

This chapter explains the research question by reviewing the empirical case study about implementation of SPEAR. The empirical case study uses the System Development Life Cycle waterfall method for SPEAR implementation. This method is described in Chapter 4.3. This study consists of requirement analysis, system design, implementation, testing, and data collection and analysis phases.

5.1 Requirement Analysis

This requirement analysis will introduce the business processes as “as-is” and “to-be”. The implementation system processes and scope is researched according to the boundaries and requirements of the FGSS. This describes the engineering planning, project resource management and document handling processes that are expected to improve with system implementation project.

The current business processes need to be researched and valued to find out which can be improved with the new SPEAR tool. The processes need to be examined critically to find the improvement areas. When a problem in the process is found, a solution is needed improve it in SPEAR. The objective of this study is to improve processes especially for engineering work planning for the LNGPac and GVU delivery projects, but also the Project Management tasks in the GVU delivery projects with SPEAR. These processes that are expected to improve, are examined closer later in this chapter.

Implementation is a time-consuming process that needs to be planned and analyzed well in order to be successful. The SPEAR tool needs to be designed as simply as possible for easy transition. All the four risk categories presented in Chapter 4.3.2 should be identified and mitigated for successful implementation. Controlling of the risks are shown in Chapter 4.3.3. The technology risk is mitigated by designing the SPEAR functions to meet the user requirements and to train the users to the new tool, so that the internalizing of the tool principle becomes easier. The organization risk is mitigated by redesigning the business processes to fit the SPEAR and FGSS requirements. The risks concerning of people are controlled by focusing on comprehensive training and changing people’s opinion about continuous improvement by involving the management team and employees closely through the whole implementation process. Understanding the reason behind the

implementation process facilitates the transition to SPEAR. The project size risk is controlled by involving project participants actively and sharing the same mindset, what data will be included and what will be the outcome.

5.1.1 Engineering Planning in FGSS

FGSS is missing a general engineering planning tool to keep track of their projects and tasks. When interviewing the engineering team, many disagreements and differences were found in the ways of work planning. Some engineers used OneNote for planning the work, others were using their own Excel templates, and the rest had no clear planning method at all.

The durations of different engineering tasks and activities inside delivery projects have not been recorded in engineering planning in FGSS. There is no data about how all the engineering working hours are compartmentalized inside one project. Engineers are marking their working hours on the project delivery level in internal engineering or internal product project management. This marking method does not present the time spent on a task level. Without a good overview about tasks durations, working hours compartmentalizing, the project scheduling is challenging and resource planning uneven. Some delivery projects can theoretically seem like an easy engineering work, but changes in the design or customer cooperation difficulties can expand the planned engineering working hours extensively. The scheduling of project work activities is inaccurate without real knowledge how engineering hours are spent inside activities. The lack of knowledge about how much effort is spent for responding to the customer comments and customer meetings distort the scheduling of task durations. This means that predicted effort needed for engineering is misleading.

Bad engineering work planning causes a possible delay or in the worst case complete oblivion on preparing the drawings and documents. That can cause a scope creep and delay in the agreed project delivering. Not being able to deliver documents on time can have a domino effect in a bigger case, delaying the whole project. Delays in project causes money loss and affects the reputation and customer trust.

To improve the engineering planning and scheduling process the task lead times, durations and dependencies need to be clarified. Differences were found in the LNGPac projects task durations depending on different delivery projects and engineers. Finding out

the engineering task durations by interviewing engineers is too difficult to collect because of project-specific fluctuation. Dependencies between different activities and tasks have not been successfully identified in complex LNGPac projects. The complexity and fluctuation in LNGPac projects make the scheduling challenging.

The SPEAR tool will help planning and scheduling the engineering tasks on a daily-basis. The new tool will work as a task list for design engineers and project engineers that displays the most critical task in every project they are involved. Engineers can get an overall picture about all of their project tasks and milestones, and what is the workload for required time scope. The tool gives Gantt chart reports about the upcoming workload. This is described in scheduling Chapter 4.5.2. SPEAR, used as a document handling platform, helps engineers to organize and follow-up their daily work.

SPEAR automatically calculates the tasks and milestones for the given contract signing to the EXW timeframe in order to project being executed on time. SPEAR calculates and chooses the tasks according to the parameters and options selected for projects. When the project is complex and has a large scope of deliveries, identified tasks are needed for every option. The tasks show the start, finish and the due date of the task. The tool calculates the earliest possible start and finish date according to the linked predecessor tasks and task durations. Without knowledge about task durations, the start and finish date cannot be put to account. However, task durations can be measured by testing SPEAR in multiple projects and collecting the data covering the time spent for each activity, to get reliable data.

5.1.2 Project Resource Planning in FGSS

The FGSS department is lacking project resource management tool that shows the workload per each employee in the given time frame. The project resource management in FGSS delivery project has been handled with a prepared Excel template, and by comparing and discussing the most suitable employees for that project. Project resources are planned and decided by the management team. Project resources are selected by employee strengths, experience by similar projects, and interviewing if the employee is capable taking the project.

The Excel template shows all the internal and external FGSS employees and work time reserved for them. The actual working time and time reserved for vacations and other

absences, for example sick leaves, are reserved and calculated for every full-time employee with percentages, depending on the location they work. All the current delivery projects and upcoming projects are listed according to contract signing to the EXW date. All the projects have estimated project durations and effort calculated with hours planned by the sales department. Hours planned per project is divided to durations in which each project team member is going to take the biggest effort. The Excel template calculates the resource sufficiency per month with all the given employee and delivery project data. The resource availability is showed by plus/minus numbers, how many employees is the department lacking to reach the planned working effort.

The FGSS organization is growing and need better ways for managing and planning the resources more efficiently. Without efficient resource planning the workload is divided unevenly between employees, and that can cause too much workload and stress for one employee. In order to achieve a successful resource planning process, the employee experience and tacit knowledge need to be taken into account. This is described in Chapter 4.5.1 Project human resource planning.

The SPEAR tool gives a possibility to receive workload – capacity reports from all the employees listed in the given time frame. The SPEAR tool enables the management team to compare the workloads according to the employee's task responsibilities. Workload – capacity reports help management to plan resources more evenly and efficiently.

5.1.3 Document Delivery Process in FGSS

The document handling delivery process in the LNGPac delivery projects is managed with external and internal Document Delivery Schedule (DDS)-templates tailored to project specified specifications. The external DDS is the table of document deliverables which shows customer inputs and customer outputs (lists, drawings, reports and calculations) delivered by Wärtsilä. The external DDS is part of technical specification in the contract and is signed by both the customer and Wärtsilä sales. The external DDS contains documents according to the scope of supply with the standard document delivery lead time. The agreed standard lead times are calculated from the contract signing date, receiving the input, or EXW date. The customer can influence the scope of supply and the EXW, which affects the document delivery lead time. In some cases, the customer can

request exceptional documents to be prepared. All the Wärtsilä delivered documents to the customer are published for the customer in the IPI platform.

The internal DDS is a master document delivery schedule table, which is used for project document handling. The internal DDS shows every project specified input and output document that needs to be received or prepared. The internal DDS shows roughly who is responsible for each document, input deeded to/from, delivery time to customer, planned date to classification society, target delivery date to design bureau, target date to manufacturing, and delivery lead times. The internal DDS is managed by the project documentation controller.

When interviewing the LNGPac engineering teams, a lot of outdated information and missing information in the document delivery process was found. The first problem was differences between the internal & external DDSs' and prepared documents. The naming of the documents was not successful, which causes confusion between engineering, project management, manufacturer and customer. The following of the document delivery is difficult without organized document categorizing and realistic delivery lead times. The external DDS was outdated and was missing some documents that should to be sent to the customer. The document delivery process is crucial for work planning, maintaining project schedule and keeping customer satisfied. This process needs to be modified and updated for better document handling.

The document handling in FGSS GVU delivery projects depends on the delivery project type. In four-stroke delivery projects GVU is part of the engines delivery, so the document delivery times are dependent on engine DDS. The GVU-documents are delivered to the engine department which releases them in their IPI. Documents that are needed to send to the supplier & classification society are delivered with the objective to meet the approved EXW date.

In two-stroke GVU delivery projects there is no existing document handling system. In these projects the EXW date is the deadline to meet. Documents are delivered to the customer, supplier and classification society to meet the approved time.

When interviewing the GVU project teams, a lack of clear and common document handling method was found. Every design engineer and project engineer had their own methods to handle the document delivery.

SPEAR is going to use the document delivery process as a base data for the engineering tasks. A realistic and organized document delivery schedule helps the whole project team to schedule their work more efficiently to meet the delivery dates.

5.2 System Design

This chapter will present the development phase of the SPEAR tool implementation. The development phase consists of designing the system interaction and function according to the requirements. That means updating the document handling and engineering processes and developing the engineering planning template that defines how SPEAR works. The working principle of SPEAR engineering planning is designed using methods presented in Chapter 4.5.2 Scheduling. At the end of system design SPEAR will be dummy tested in the testing environment. The purpose of testing is to find possible system failures and to determine how well the various processes will work in the proposed system.

5.2.1 Document Delivery Redesign

Redesigning the document delivery process is a mandatory task in order to get SPEAR interaction and functioning to work according to the requirements. SPEAR will use the document engineering as an engineering task. Developing the engineering tasks for engineers and project engineers, a good overview of the documents is needed.

Document delivery schedules are used for document handling in the LNGPac projects. Meetings between the LNGPac engineering team and engineering management, project management and document controlling were held to determine the redesign, the standard document and naming that will be used in every Wärtsilä platform. In these meetings all the documents were analyzed to solve what documents are dependent from which options and parameters. The document delivery lead times were redesigned when the document should be delivered and to where; to customer, to manufacturer or/and to classification society.

A large number of documents and varying lead times caused lack of document management inside the project team. Therefore, document delivery needed to be divided to document packets to standardize the lead. times. Documents were grouped to different doc-

ument packs with a responsible person and standard lead time. By organizing the documents to packs the document delivery process follow-up eases considerably and engineering scheduling gets easier.

External DDS and internal DDS were formatted again with updated information to match together. The updated DDS was presented to the sales team to use as a proposal for LNGPac project document deliveries for the customer. The updated DDS improves the scheduling to be more realistic and the document delivery more standardized.

The GVU document delivery process is more straightforward with less documents to deliver and a more standardized design. The GVU focus group was interviewed to find out the customer inputs needed to prepare the documentation, which documents are dependent from different options and parameters, and when the documents are needed to prepare. The durations and dependencies for each task were collected to design the system tasks.

The updated data was collected and used as an input for designing the tasks and scheduling in the SPEAR engineering planning template. The redesigning of the document delivery process makes it possible to use SPEAR as a document delivery supporting tool for delivery projects.

5.2.2 Designing the SPEAR Functions

SPEAR uses Engineering Planning Templates to define how the system is used. The engineering planning template is prepared in Excel for importing the project specified data to SPEAR. The template determines tasks, milestones and responsibilities that work as inputs to SPEAR when the project is created.

Every task has its own task type and name, owner, accountable and responsible person that is determined in template. Every task has defined the due date and possible predecessor tasks that are needed to be prepared before that particular task. A base effort can be added to the task for recourse capacity scheduling, if the task duration is known. A checklist can be added to each task to determine what documentation is needed to be prepared or received in that activity.

Tasks are linked to milestones. A milestone is a specific point in time in a project delivery lifecycle used to measure the progress of a project toward its ultimate goal. When selected set of tasks are competed, the milestone is achieved.

The LNGPac and GVU projects are always sold with a set of parameters and options which makes every delivery project different. The parameters and options are determined in the Engineering planning template. Parameters and options can be selected when adding the delivery project to SPEAR. The template calculates correct tasks needed to execute the project with the selected parameters and options.

The LNGPac Engineering planning template was designed to use the redesigned document delivery packs as engineering tasks in SPEAR. Every user sees their own document packs with a certain checklist of documents included depending on which parameters and options are selected. When all the documents in the checklist are checked out, the task can be completed. With this way of scheduling the tasks help engineering to organize and schedule their daily work, maintain a task list, and get a better insight in collaborative engineering functions. Engineering tasks work as a predecessor for project engineer tasks, delivering the documents to different stakeholders. When all engineering tasks with the same due date are completed, the project engineer can complete delivering the documents task. This SPEAR interaction ensures that all documents get prepared and delivered on time. This SPEAR function helps the project engineer to see the status overview of engineering tasks for projects, time schedule for each engineering task, and the list of deliverables.

Designing the engineering planning template for the GVU delivery projects was more straightforward because of a better knowledge of different project activities and dependencies. The template was designed to cover all major engineering and project management tasks from the contract signing to the EXW date. The template will calculate automatically all the dependencies between activities and calculates the latest due dates for each task in order to meet the EXW date. A more straightforward delivery process made it possible to use SPEAR to support engineering and project management processes throughout the complete delivery project.

5.2.3 Dummy Testing

The approved engineering planning templates were transferred to the SPEAR testing environment for dummy testing the system interaction and functioning. Multiple real projects were created and run through the dummy test to find out the problems and mistakes in the task scheduling and organizing. In this testing phase the fixes were made, and the software was updated according to the found errors. After the dummy testing, the system was implemented to the production environment.

5.3 Implementation

This chapter presents the implementation process after SPEAR is approved for the production environment. The implementation phase includes test group training and pilot delivery projects testing. The challenge in the implementation is to change from the old systems to the new one, without causing unnecessary harm and interruption in the processes, or the employee's work. The training needs to be comprehensive enough for employees to adopt the new system quickly. The employees need to understand the general idea why FGSS is transitioning to SPEAR and an overview of the system logic and potential benefits for their own work. The testing phase needs to be completed carefully in order for the deployment stage to run as smoothly as possible.

5.3.1 Training

The implementation phase started with two different SPEAR introduction meetings with user groups from both the GVU and the LNGPac pilot delivery project teams. The user groups were introduced to SPEAR. The training was organized with generally opening and visualizing the following questions;

- What SPEAR is,
- Who is going to use SPEAR,
- Why we use the SPEAR,
- How to use SPEAR,
- What are the tasks and milestones in SPEAR,
- Who is the responsible person for each task,
- How to use SPEAR in engineering planning and checklists,
- How to use SPEAR in document handling,

- How different options affect the project scope of supply,
- What are the color codes,
- How to complete the task,
- How to personalize the SPEAR layout for you,
- How to handle the revisions and rescheduling,
- How to mark the working hours,
- How to add project to SPEAR.

After the training session, the participants had a possibility ask questions and engage in open discussion. At the end of the training event the common way of working with SPEAR was agreed with all the participants and SPEAR was officially taken to use for the GVU projects and LNGPac pilot project.

After training the test groups, the SPEAR Key user group that is responsible for developing the tool was selected and trained. The key user group consists of employees from every user section; LNGPac and GVU engineering and project management, management, operation excellence and SPEAR technical support. The training included presentation about the SPEAR tool and the principle of developing and redesigning it. The responsible person/persons were selected for developing this tool and other activities, that are related to SPEAR.

5.4 Testing

The testing phase includes testing SPEAR in the production environment with real time delivery projects. The testing is performed to ensure that the SPEAR tool meets the requirements and to ensure that the tasks and scheduling is realistic. In this phase the benefits and necessity of the existing data is verified and collected. All the system problems and feedback are also collected for developing the next upgraded version.

The testing of GVU delivery projects started with adding all the projects signed since the October 2018 into the system. Adding old projects to the system caused problems with scheduling start and finishing dates of the tasks. The users had to mark and complete all their past project tasks into the system. Completing the past tasks takes time but also practices the users to work with the new tool.

The testing of LNGPac delivery projects was performed with a pilot project. The new delivery project was selected for the pilot project to test the functionality of SPEAR and the new proposed DDS with updated document delivery packs. The purpose of the pilot project test group was to follow the SPEAR tasks and due dates to find out the benefits of redesigned processes.

5.4.1 Support

The testing phase includes supporting the testing groups. Active clerical support was carried through the testing phase. When a problem or a question about SPEAR functioning appeared, the user could ask help by email, Skype or face to face.

A user instruction manual for SPEAR was prepared to support the transition to the new tool. The instructions were shared to the common Fuel Gas Handling team's page in the MS OneNote information sharing program where everyone could review it. The instructions present general information about the SPEAR tool and step-by-step instructions for customizing the SPEAR layout, finding and completing the tasks, creating own tasks to system, reporting hours, rescheduling & revision handling, and adding projects to SPEAR. The FGSS SPEAR user instructions can be found in Appendix 3.

5.5 Data Collection and Analysis

In this chapter methods for collecting the date and data analysis is presented. Data collection is part of implementation to record the outcome. Data analysis is analyzing the collected data to find out if the objective was met, what the effect of implementation project was, if the outcome was expected and if the data was reliable.

5.5.1 Collecting the Data

Data collection was performed with follow-up meetings and feedback reports from the MS OneNote information sharing program. The follow-up meetings were controlled group meetings with both test user groups independently. The purpose of the meetings was to collect data from the users about how they see the effects of the SPEAR and how it could be improved. The first meetings were arranged after three weeks of the testing. The meetings were open discussion style interviews where review questions were presented for the test user groups. The interview questions can be found in Appendix 2. The

second meeting was held five weeks after the testing for the GVU test user group. The same review questions were presented to find out to discover new findings.

The OneNote platform has a possibility to give feedback and improvement ideas personally. The key users group is going to use this feedback platform to analyze and develop the system functionality in monthly meetings.

5.5.2 Data Analysis

Data analyses were prepared based on the data collected from the feedback of the test user group and predictions what effects SPEAR have in the long run.

Benefits

SPEAR helps users to maintain a task list about their work in a common platform which makes an overview of the tasks manageable and helps delivering the documents. SPEAR facilitates the organizing and scheduling of the users' daily work better. Task are quick and easy to retrieve, and the tool is clear to use with the possibility to personalize the layout. Task deliver the correct information that is needed for work planning. With the training and user instructions, the transition to SPEAR was smooth and thereby no much clerical support was needed. SPEAR makes it possible for project engineers to get an overview of engineering tasks and follow-up the project progress.

Reporting project hours for CATS reporting is easier and faster. The possibility to mark working hours on an individual task level enables the possibility to measure the task durations of engineering planning and project management, which are needed for delivering the project. The team leaders can use this received data to improve the future hour planning for projects and find out what activities take the most working hours and improve those sections. When realistic task durations are measured, the team leaders can follow the workload of individual employees better and receive workload reports and task reports in project level.

Disadvantages

The user groups find that they do not have enough time to use SPEAR and orient themselves to the tool possibilities. Using the new tool takes practise before getting comfortable with the system. SPEAR cannot be followed precisely but rather used as a guideline

to work planning. The system does not eliminate the need of information sharing between users.

SPEAR has a system software problem that the test group found as a disadvantage. SPEAR has occasional problems with the SAP/CATS interface, which causes problems with marking hours. This problem needs to be reported for the system support for further research.

Reliability and Validity of the Data

The validity of the collected data is ensured by planning the interview questions to elicit the needed information. The needed information is to find the benefits and disadvantages of the system and find out possible development ideas for further development. This information can be reflected to answer research question and evaluate how successful the implementation process was.

The reliability of the collected data is quite a narrow due to the limited time in study and long delivery times in projects. Data was collected from both user groups, but the study focused more to the GVU delivery project because of a wider scale of projects and participants to get more reliable data. Delivery times are shorter in the GVU delivery projects, so data could be collected from a longer project time frame. The review interview was repeated twice for the GVU test group to collect findings from a longer time frame. Participants had also more time to test the system functions. To obtain reliable data from the LNGPac projects the testing phase should last months or even years to see if the system is functioning perfectly. All in all, the findings were very similar in both test groups and both user groups found the system to help them in daily work. Findings between separate users were not differing significantly and the test group agreed on the findings in most of the questions.

Some resistance to change was detected inside the test groups. Most of the test group users started using SPEAR actively on a daily basis, but some did not have time to orient themselves to the new implemented system. This affects the reliability of received feedback. The test users that were not using the SPEAR actively could not give reliable answers to all the interview questions. These people related risks are described in change process and commitment phases in Seven C's model in Chapter 4.3.3.

5.6 Analysis of the Study

This section gives suggestions how the company should develop the implemented SPEAR tool after this study to achieve the best benefits of the implementation project.

The SPEAR tool needs to be tested further to get more feedback from the users. Testing needs more projects with more participants to find the development areas and receiving a wider scale of opinions. The functioning of SPEAR and LNGPac DDS must be proven to work in a long run. The testing phase needs to be completed carefully in order for the deployment stage to run as smoothly as possible. This phase is described in Chapter 4.3.1 Phases in implementation project. The compatibility between SPEAR and current projects that are delivered with the old DDS must be tested, and the effort to modify the system needs to be solved.

In the deployment phase, SPEAR is introduced to all users and all current and new projects should be added to the system. The accepted system includes the user training that needs to be comprehensive enough for employees to adopt the new system quickly. This is showed in Chapter 3.3.1 Phases in implementation project and in the champion phase in the seven C's model in Chapter 4.3.3.

The completed deployment of the system is by no means the end of the system implementation project. After the deployment, the maintenance phase starts where the users focus on operating SPEAR to ensure that the data is up-to-date, and it continues to function properly. The importance of maintenance is described in Chapter 3.3.1. The Key user group continues the SPEAR training for new users as well as supporting the usage in order to make necessary changes and upgrades when needed.

The next development idea is linking dependencies between tasks and customer inputs for more realistic scheduling in SPEAR. Interface problem between SPEAR and SAP/CATS must be reported for the system support for further research.

Marking working hours on a task level can be started to solve the task durations. Project task durations help planning the engineering process effort better. With a more realistic project planning comes more efficient resource planning. The suggestion for task reminder ability and automatic start-up function for SPEAR should be presented to the system support.

6 CONCLUSION AND DISCUSSION

Modern businesses, including FGSS, are constantly in need to improve processes and implementation tools to support the work in order to keep up with the competition. The SPEAR tool can provide significant help in work planning in an individual employee's daily work and on a project level. SPEAR is not a final solution to work planning and scheduling and it cannot predict unexpected activities or changes in projects. Employees still need to use common sense in their work planning and share information inside the project team. SPEAR also needs a constant development in order to meet changing requirements. Despite the challenges, the tool provides many possibilities to improve the business processes.

The purpose of this study was to answer the research question: How to implement engineering planning and resource management tool SPEAR in engineering planning and project management in Fuel Gas Supply Systems?

The case study was a challenging and long process because of the tool requirements and working principle changed many times during designing. The processes had to be redesigned and approved many times before being able to import the proper data to the SPEAR. This reflects unsuccessful project size risk management, which is described in Chapter 4.3.2. Researching the tasks was a wide and challenging process due to many variables. The focus groups' needs and opinions had to be taken into account in order to compile a working outcome.

After comprehensive research and testing, the SPEAR was implemented for testing and the results were collected and analysed. The data analysis prove that the study reaches the objective by answering the research question. This proves successful technology risk mitigation in the implementation phase which is described in Chapter 4.3.2.

Limitations during completing this study were that the opinions and approval of focus groups of Wärtsilä FGSS were required at many stages, which took time in the case study. The study was much dependent from the participation and availability of focus groups. The study dependency from participants' schedules and working for the company besides the study caused a delay in original implementation schedule. The time limitations narrowed down the findings of this study in a long run.

Implementing the SPEAR is a big commitment to FGSS. Using and developing the tool requires careful planning, management, and participation from all organizational divisions as well as support from the top management.

6.1 Theoretical Implications

The theoretical part of this thesis was meant to provide insight into the project processes, project process improvement, and system implementation. This part was researched by going through various literature sources. The process improvement and different kind of system implementation is a widely researched subject but there is not a recorded study about the implementation of SPEAR or the possibilities of it. The theoretical part of this study helps to understand the importance of process improvement in projects and presents the system implementation process widely and the benefits and risks it could cause in Chapter 4.3. The ERP and SPEAR tool in Chapter 4.4 introduces the system benefits that the company can receive by implementing them. SPEAR is constantly developed as a system as new features are added to the systems. This study helps FGSS and other departments to implement and develop the SPEAR tool successfully to meet their requirements.

The planning in Chapter 4.5 helps to construct the overview of the processes what the SPEAR tool is improving and what kind of planning and scheduling methods are used. This supports designing the system functions and reduces the risk of bad system planning. Being familiar with project planning, the system working principle and implementation planning is easier to internalize.

6.2 Practical Implications

After this study engineers and project engineers are able to maintain task list about their work in common platform which makes an overview of the tasks manageable. The implemented SPEAR tool enables engineers to organize and schedule their daily work better and get the overview of engineering tasks and follow-up the project progress.

After the implementation of the system, engineers are able to mark their working hours on a task level, which enables the possibility to measure the task durations, which are needed for delivering the project. This improves the future hours planning for projects and find out what activities take the most working hours and improve those sections.

When realistic task durations are measured, the team leaders can follow the workload of individual employees better and receive workload reports and task reports on a project level.

The SPEAR implementation is a major step to continuous process improvement management that is described in Chapter 4.2. The consequences of certain activities concerning the SPEAR improvement are far reaching and therefore must be researched afterwards by the key user group. The accepted system needs to be deployed after comprehensive testing. The deployment needs to be scheduled and include comprehensive user training for employees to adopt the new system quickly. After the deployment, the maintenance phase starts where the users need to focus on operating SPEAR to ensure that the data is up-to-date, and it continues to function properly. These phases are described in Chapter 4.3.1.

SPEAR can be further developed to be used also in project management for the LNGPac Delivery projects, task planning for Sales projects, and Development (R&D) projects. SPEAR has potential to be used as a common engineering planning and resource management tool for other departments linked with FGSS.

REFERENCES

/1/ This is Wärtsilä, Wärtsilä home page. Accessed 7.1.2019. https://www.wartsila.com/about.

/2/ Wärtsilä Corporation Annual Report 2018, Wärtsilä website. Accessed 7.2.2019. https://wartsila-reports.studio.crasman.fi/file/dl/i/7ADanw/10gpJKZvv_t3yfS-vYnoBA/Wartsila-Annual-Report-2018.pdf

/3/ Fuel Gas Supply Systems, 2018-12-04, Wärtsilä internal website. Accessed 7.1.2019. https://wartsila.sharepoint.com/sites/compass/productsandsolutions/gasproductssolutions/fuelgas%20handling

/4/ LNGPac, 2018-03-16, Wärtsilä internal website. Accessed 7.1.2019. https://wartsila.sharepoint.com/sites/compass/productsandsolutions/gasproductssolutions/fuelgas%20handling/lngpac#

/5/ Wärtsilä Solutions for Marine and Oil & Gas Markets 2017. Accessed 7.1.2019.

/6/ Gas Valve Unit, 2016-05-09, Wärtsilä internal website. Accessed 7.1.2019. https://wartsila.sharepoint.com/sites/compass/productsandsolutions/gasproductssolutions/fuelgas%20handling/gvu

/7/ Vaidyanathan, J.2013. Project Management: Process, Technology, and Practice. Pearson

/8/ Avison, D. and Fitzegerald, J. 2003. Information Systems Development Methodologies, Techniques and Tools, third edition. McGraw-Hill Education.

/9/ Existek, SDLC Models Explained: Agile, Waterfall, V-Shaped, Iterative, Spiral 2017-04-08. Accessed 5.2.2019. https://existek.com/blog/sdlc-models/

/10/ Motiwalla, L. F. and Thompson, J.2012. Enterprise Systems for Management. 2nd Edition. Pearson.

/11/ Vilpola I. and Kouri I., J. 2006. Toiminnanohjausjärjestelmän hankinta C-CEI-menetelmän avulla : joustaako yritys vai järjestelmä? Teknologiateollisuus.

/12/ Sumner, 2000-1-12. Risk factors in enterprise-wide/ERP projects. Accessed 12.2.2019. http://www.wikiparhan.com/wp-content/uploads/2016/07/ERP2.pdf

/13/ Cooper & Kaplan, J.1991, Design of Cost Management Systems: The, Text, Cases and Readings. Englewood Cliffs, NJ : Prentice Hall.

/14/ SPEAR User guide, Wärtsilä internal website. Accessed 10.11.2018

/15/ Huges B. and Cotterell M., J.2006. Sotfware Project Management. 4th ed. McGraw-Hill.

/16/ Lucidchart, PERT Chart Templates. Accessed 12.2.2019. https://www.lucidchart.com/pages/pert-chart-templates?a=0

/17/ Planio, How to Create a Gantt Chart in Excel (Free Template) and Instructions. Accessed 12.2.2019 https://plan.io/blog/gantt-chart-excel-template/

/18/ Tutorialspoint, SDLC – Overview. Accessed 5.2.2019. https://www.tutorialspoint.com/sdlc/sdlc_overview.htm

APPENDIX 2

Follow-up Meeting Review Questions

- Will the SPEAR deliver the information I need for my work?
- How quickly can I access the data?
- How easily can I retrieve the data?
- How much clerical support will I need to enter data into the system?
- How will the operation of the system fit into my daily business schedule?
- How SPEAR help me in work?
- How could the SPEAR be improved?
- Other matters?