Increasing project management maturity in the ship repair industry

Towards a project management approach for large non-standard projects

Laura Gallis – 29-05-2015 – Delft University of Technology

Abstract

The ship-repair industry is well-known for increases in project duration, costs and scope. Both client and company know that the estimates that have been made at the start of the projects are likely, almost inevitably going to change. Generally these changes are accepted and resolved along the way. However, this situation might change when the economic environment changes. Ship owning companies can hire organizations that stand between them and the yard, to prevent the changes within the project from affecting the outcome. The yards in their turn have inefficiency problems caused by the increase in time. To prepare for the changes in the market and improve the general yards’ processes this paper has focused on the problems that occur in large non-standard projects executed in four different ship-repair yards. These results have been compared to existing project management approaches to determine whether these are applicable to the ship repair environment. The result has been a project management maturity approach for the ship repair industry to improve the level of project management in large non-standard projects.
Introduction
Project management within the construction industry has proven to be a very interesting subject for practitioners and academic researchers (Akkoyun & Dikbas, 2008; Bennett, 1983; Hendrickson & Au, 1989; Lock, 2012; Walker, 2015). Projects become bigger and more complex over time (Špundak, 2014), which makes them harder to manage. This complexity is caused, amongst other aspects, by an unknown, unclear or incomplete scope.

Over the years the theory on project management has mostly been focused on projects with a well-defined scope, tight budget and strict planning (Špundak, 2014). In these studies risks are managed, uncertainties mapped out and taken into account in the management process. This is possible in certain environments, with relatively stable scopes, limited uncertainties and manageable risks. However, in a more dynamic environment the scopes are often unclear, contain many uncertainties at the start and high levels of change, caused by forces out of the projects’ control (S. Collyer & Warren, 2009).

The project management iron triangle (Figure 1) is designed to manage and measure projects and its success. The triple constraint of cost, time and quality (or scope) shows the relation between the three. It focused evenly on a set time, budgeted cost and specific quality during a project (Atkinson, 1999). However it is often mentioned that to successfully comply to two of the constraints will require a sacrifice in the third. A project that is executed on time and to the preliminary set quality will probably be over budget (Bethke, 2003). A variation of this triangle has been presented by Ogunlana that also incorporates safety, efficiency and effectiveness (Ogunlana, 2010), as they state that the iron triangle is too limited. A change of the traditional triangle was necessary to be able to manage projects that have a greater focus on a specific but uncertain scope (quality) and a fixed time and budget, the so-called Agile iron triangle (Figure 2) (Adjei & Rwakatiwana, 2010; Serrador & Pinto, 2015). This triangle allows managers to execute a project with an undefined or unclear scope. It is an example in which project management approaches adapt to changes in the market and environment (Špundak, 2014). For an environment which has a high level of uncertainty and unknowns it is has been a step in the right direction but does not yet offer a complete picture. Collyer has provided research regarding so-called dynamic environments and approaches to handle them (S. L. Collyer, 2013), however such studies are recent phenomena and have had limited testing in empirical research.

Adding to the increasing complexity of uncertain projects is the fact that projects are often not executed as a single entity, but in parallel with other projects (Turner & Speiser, 1992). Resources have to be shared with other projects and adding extra pressure to time management as other projects are lined up (Payne, 1995). Making an overall planning and resource distribution for a group of uncertain projects is even more complex than for projects that are more stable. An opportunity that large companies have and could make the situation easier is that they might have multiple locations at their disposal in which to execute their projects. Having this option provides opportunities in managing their projects, but it also has its pitfalls as well. In order to provide a framework towards a management approach that is suitable for controlling projects in a dynamic multi-project, multi-location environment this aspect will be used as an additional environment.
Increasing project management maturity in the ship repair industry

Research subject

A working environment that faces uncertainties and a high level of changes in their projects is the ship repair sector. Companies execute projects in parallel, share docks, work force and other resources. The market is characterized by an uncertain demand and projects generally have large uncertainties in their scope, budget and duration (Bruce & Evans, 2006) and they can have multiple yards either within or outside the country.

The demand-market of the ship repair sector is uncertain and varies throughout the year. Where one yard struggles to attract enough resources to execute the projects at hand, another watches the cobwebs grow in their docks and their resources and assets stand still. Due to the uncertainty a yard can also perform outstandingly three months in a row, creating optimal revenues, while standing still the next months and diminishing the earlier made profit. To deal with this market it is important to know what to expect of the projects that are taken on, both financially and time-related.

Financial estimates are made using a scope description from the client which is often incomplete and unclear. In most cases the first time the ship is seen in real life is when it is already booked and located in the yard, ready to be taken on. A consequence of this is that the final costs made to execute the project often become higher than estimated. On the one hand this is negative, because the client will have to pay more (depending on the contract) which could affect the relationship. On the other hand this is positive because it could mean that there is a higher turnover on the project, increasing profit (Bruce & Evans, 2006). This is an essential aspect of the ship repair business model.

To keep up with modern times, managers should consistently keep a close eye on changes that could affect the firm’s ability to create value for customers and react accordingly to changes in their environment and competitors (Sirmon, Hitt, & Ireland, 2007). The clients in this market are used to the fact that repair operations of their fleet will be more expensive than originally estimated at the start of the project. Running into extra repairs during the project execution is almost seen as a fact rather than a risk. Most clients currently accept this financial increase, but it has been observed that a change in the market is occurring. Because the clients have limited knowledge over the details of the repair activities, they tend to hire purchasing consortia to manage their side of the project to limit the delay and cost increase. This is a trend that can threaten the current work processes of repair yards. Continuing the execution of these projects this way can become their downfall. In order to anticipate on these changes more control within the projects is necessary and this will be the focus of this research.
This research has been conducted at the yards of Damen Shiprepair and Conversion, a division of the Damen Shipyards Group. This division has grown rapidly over the last decade and operates in multiple yards around the world, with a main office in Rotterdam (Rotterdam, 2011). Most yards belonging to the division were not originally built for the division itself but have been gradually acquired. Each yard works with different systems and has its own culture (both within the company and in terms of nationality), the division is currently aligning these yards. The earlier mentioned problems that are general for ship repair yards are also present at Damen.

The projects that are executed at the Damen yards can be divided roughly in two types. The first being the standard maintenance projects. In this case the vessel comes in for cleaning, blasting, painting and other small maintenance items or repairs. The second category consists of the larger projects in which the vessel comes in for one of three reasons:

- Refit/life time extension, extensive maintenance on the vessel and upgrading the equipment to modern standards
- Conversion, changing the purpose and use of the vessel
- Repair, restoring the vessel after sustaining damages

The difference in management approach between the two types of projects is the familiarity with the process. The first type are projects with standard activities, the second type encompasses a large variety in activities. Every project of the second type is unique in its scope and goals. This requires a different project management style than in the standard projects. These non-standard projects generally have a large turnover and have many uncertainties in their scope and requirements for completion. The research will focus on these so-called non-standard projects, where there is room for improvement and the (financial) risks are high.

An additional aspect that makes the ship-repair industry interesting is that their business model includes that a large part of the profit is made in the additional work that arises in the projects.

The preliminary analysis will start with a literature review of the theory related to ship-repair, multi-project management, project management in uncertain or dynamic environments and similar studies. Next the problem is formulated and finally the research question is introduced.

**Theoretical basis (literature review)**

Previous research in the ship repair industry has been for example on information systems (Bruce & Evans, 2006; Mourtzis, 2005; Turner & Speiser, 1992), resolving resource conflicts (Salimifard, Jamali, & Behbahaninezhad, 2012) and multi-project planning (Hans, Herroelen, Leus, & Wullink, 2007). The coming section will provide insight in the environment of the ship-repair industry and a review of the available literature that is relevant in this research.

The fields that are part of the environment of the research are multi-project management and project management in dynamic or uncertain environments (Figure 3). The multi-project management environment has specific characteristics that make it different from single-project management. This is the environment in which the projects in this research are executed and describes the already known difficulties that can arise. Within the multi-project environment the projects are characterized by uncertainty and dynamism. The approaches regarding the management of these projects is the second theoretical field.

![Figure 3 Fields of research](image-url)
From stand-alone projects to multi-project environments

Project management initially started out as an individual act, in which a project is defined as a temporary endeavor undertaken to create a unique product or service (PMI, 2004). Within the project management terrain a lot of approaches, frameworks and research have been designed and conducted to find ways to manage projects. PRINCE2 and PMBOK are mere examples of these frameworks. These have been created from a single-project point of view and are focused on achieving single project objectives, since these methodologies were the first encounters with project management in general. (Aritua, Smith, & Bower, 2009)

Turner and Speiser mentioned in 1992 already that about 90% of total project activity takes place in a multi-project context (Turner & Speiser, 1992). Since then, various literature has been written on multi-project environments (MPE’s), because the tendency to keep using the single project management methodologies in a multi-project environment is identified as an improper way to manage them (Aritua, et al., 2009).

In Table 1 the characteristics of both the single-project environment and the multi-project environment have been summarized. The overall difference that repeats itself in these characteristics is the fact that the projects have to share the facilities and resources available with other projects. The managers responsible for the set of projects need to determine priorities within this set. This can change day-by-day and decisions have to be reviewed continuously (Turner & Speiser, 1992). The issues that arise within multi-project management are, amongst others, the relations between projects and handling resource scarcity according to the overall strategic direction of the corporation (Laslo, 2010).

Research regarding characteristics of the multi-project environment is extensive. Maylor discusses the implications multi-project management has on several parts of the business cycle (Maylor, Brady, Cooke-Davies, & Hodgson, 2006), Aritua focuses more on the fact that trust and information-sharing is essential in these situations (Aritua, et al., 2009). Dooley identifies three categories of challenges within multi-project management and provides separate tools to cope with these, while Blismas finds factors that could have an impact on project success (Blismas, Sher, Thorpe, & Baldwin, 2004).

Not only the characteristics, but also the impact the environment has on the organizational structure is popular. The complexity of executing multiple projects in parallel calls for a different strategy of management in the upper level. This has been the driving force behind for instance the design of the matrix structure for companies, but still there are a lot of hurdles to overcome within MPE’s. Platje stated that the management of multi-projects instead of single projects requires a change in the organizational structure (Platje, Seidel, & Wadman,

<table>
<thead>
<tr>
<th>Single-project environments</th>
<th>Multi-project environments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects deliver well defined, isolated and independent objectives</td>
<td>Deliver related objectives which together contribute to the overall development objectives of the parent organization</td>
</tr>
<tr>
<td>Relatively independent from all other projects and operation being undertaken by the parent organization</td>
<td>The projects have interfaces with other projects and day-to-day operations, sharing common deliverables, resources, information or technology across those interfaces</td>
</tr>
<tr>
<td>Each project is assigned a dedicated team of resources that is wholly within the control of the project manager, who manages the team’s priorities to deliver the project’s objectives within constraints of time and cost</td>
<td>The projects share resources with other projects and day-to-day operations, and must negotiate priority for those resources on an almost daily basis</td>
</tr>
</tbody>
</table>

Table 1 Characteristics of project environments (Turner & Speiser, 1992)
Increasing project management maturity in the ship repair industry

1994). The higher level management should allow project managers to manage projects on their own and focus on the group of projects as a whole. They should seek a balance between trusting project managers and allowing them to concentrate on details while seeking the necessary level of control and accountability (Aritua, et al., 2009). A model that is also based on the organization but has its focus on control is that of van der Merwe (van der Merwe, 1997), providing tools to maintain control by using limited resources.

Turner & Speiser are one of the first ones that adapted the single project management approach of one project manager to a complete model where three managers are in charge of multiple projects and each have their own role (Turner & Speiser, 1992). The interdependencies between projects are the main reason why managing multi-project environments must be done differently than a single project (Blismas, et al., 2004). Based on the model of Turner and Speiser, Platje created a comprehensive framework linked to the organization and project-breakdown structure that is focused on decision making (Platje, et al., 1994). This was based on their earlier work that stated that delegation is the keyword in multi-project management (Platje & Seidel, 1993). The competition among projects for the allocation of individual experts can lead to disagreements (Platje, et al., 1994). This is why there is also a lot of interest in the practical side. This has resulted in several planning tools and models, for example one of the more comprehensive models comes from Kao with an integrated makespan and cost tradeoff analysis which can be used as a basis for decision making (Kao, Wang, Dong, & Ku, 2006). Additionally several researches to improve and facilitate planning and resource management have been conducted over time (Engwall & Jerbrant, 2003; Hans, et al., 2007; Laslo, 2010; van der Merwe, 1997).

The literature regarding multi-project management provides insight in the problems and characteristics that come with multi-project management. These characteristics and problems are also found in the ship-repair industry. The models and solutions provided in the literature to manage this environment have been used to compare the results from the research and provide improvements and understanding.

### Project management in an uncertain/dynamic environment

The Project Management Institute defines traditional project management (TPM) as “the application of knowledge, skills, tools, and techniques to project activities to meet project requirements” (PMI Inc & Chapter, 2009) and stresses that TPM work is concerned with fulfilling the demands for scope, time, cost, risk, and quality within the framework of predetermined stakeholder requirements. Other definitions are all similar or can be found in the same range (Špundak, 2014). Researchers and practitioners

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Traditional approach</th>
<th>Agile approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>Clear initial requirements; low change rate</td>
<td>Creative, innovative; requirements unclear</td>
</tr>
<tr>
<td>Users</td>
<td>Not involved</td>
<td>Close and frequent collaboration</td>
</tr>
<tr>
<td>Documentation</td>
<td>Formal documentation required</td>
<td>Tacit knowledge</td>
</tr>
<tr>
<td>Project size</td>
<td>Bigger projects</td>
<td>Smaller projects</td>
</tr>
<tr>
<td>Organizational support</td>
<td>Use existing processes; bigger organizations</td>
<td>Prepared to embrace agile approach</td>
</tr>
<tr>
<td>Team members</td>
<td>Not accentuated; fluctuation expected; distributed team</td>
<td>Collocated team; smaller team</td>
</tr>
<tr>
<td>System criticality</td>
<td>System failure</td>
<td>Less critical systems</td>
</tr>
<tr>
<td>Project plan</td>
<td>Linear</td>
<td>Complex; iterative</td>
</tr>
</tbody>
</table>

Table 2 Difference TPM and APM (Špundak, 2014)
Increasing project management maturity in the ship repair industry

have been seeking alternative methods for project implementation, recognizing that traditional models for planning and execution may not be optimal or tuned for the specific challenges that projects face (Serrador & Pinto, 2015). This has been the reason for the popularity of other project management models, such as Agile Project Management (APM) (Dybå & Dingsøyr, 2008). Agile originates from the IT sector (Špundak, 2014), in which the scope is the most important aspect. The IT projects have a clear goal of what the end result should be able to do, however what kind of work and how much is necessary to obtain that goal is unclear. The Agile approach is focused on project management as an iterative process (Adjei & Rwakatiwana, 2010). APM has an emphasis on continuous design, flexible scope, freezing design features as late as possible, embracing uncertainty and customer interaction. While TPM pursues a goal of logical sequencing that requires deliverables to be set in advance and project development evaluations based on performance at a series of capabilities gated reviews. These reviews can result in excessive rework, lack of flexibility, customer dissatisfaction (Serrador & Pinto, 2015). The differences between TPM and APM have been summarized by and can be found in Table 2 (Špundak, 2014). He states that both approaches have their advantages and disadvantages, but it is often necessary to use both and that the methodology should be adapted to the project and not the other way around.

The relevance of the development of a new project management approach lies in the fact that the nature of the projects change. Other environments provide other circumstances. One of the environments that has gained popularity with researchers is the uncertain or dynamic environment. The APM approach is a development that plays into this direction.

In the dictionary, he term dynamic is formulated as: “(Of a process or system) characterized by constant change, activity, or progress” (Oxford, 2014). When referring to environments and the management of environments, this can be formulated as: “The organization and coordination of the activities of a business that is characterized by constant change, activity, or progress in order to achieve defined objectives” (Dictionary). A dynamic project is taken to be one that is necessarily subject to higher than

<table>
<thead>
<tr>
<th>Work type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td>Established controls. ‘Operational’ processes. Lower levels of unknowns.</td>
</tr>
<tr>
<td>Classic project</td>
<td>Requires the creation of new controls, usually a project plan, for a significantly new body of work, usually only carried out once. May have high levels of unknowns at the start but most resolved early, and few new unknowns arise during execution.</td>
</tr>
<tr>
<td>Dynamic project</td>
<td>Requires the creation of new controls that are changed regularly during execution. Has high levels of unknowns at the start and a high rate of new unknowns throughout. Must resolve the unknowns at a faster rate than they appear, and in time for completion.</td>
</tr>
</tbody>
</table>

Table 3 Project categories (S. Collyer & Warren, 2009)
normal levels of change due to the environment in which it is conducted. In which the dynamism is a non-binary dimension, a project is neither dynamic or non-dynamic. Figure 4 and Table 3 show the categorization Collyer has made in the difference in dynamism in projects. He identified approaches that might help in the management of these projects and has also conducted research regarding the application of these approaches in practice (S. Collyer, Warren, Hemsley, & Stevens, 2010; S. Collyer & Warren, 2009).

Project management approaches are closely related to project management success. The chosen project management approach has a large influence on the outcome of the project. The project management triangles are primarily used for measuring the projects’ success. This brings up the issue of deciding to what success factors should the project be measured. Spundak states that the ultimate goal of the traditional management approach is optimization and efficiency in following the initial detail project plan or to finalize the projects within planned time, budget and scope (Špundak, 2014). Atkinson argues that project management continues to fail because the definition of success criteria in the classic iron triangle are too limiting. He suggests that other criteria should be accepted, such as client satisfaction or use of the product. Instead of delivered on time, within budget and according to specifications (Atkinson, 1999). Kerzner has added the acceptance of the customer/user, within minimum or mutually agreed upon scope changes, without disturbing the main work flow of the organization and without changing the corporate culture. He introduced a new triangle, which can be found in Figure 5 (Kerzner, 2013). Whereas Ogunlana has introduced a triangle that further expands the measure of performance in Figure 6 (be it in large construction projects) (Ogunlana, 2010). It includes the efficiency and effectiveness of the work that has been done and emphasizes the need for execution in a safe environment. Also the stakeholder is involved more, as the expectations from and disputes with the client and other stakeholders are taken into account.

The literature regarding management approaches for different environments have provided a basis from which solutions can be chosen and identify gaps in the models where they are not applicable to the ship repair industry.

**Problem formulation**

In a stable environment, in which the scope and duration of a project is generally stable and the outcome predictable (S. Collyer, et al., 2010), managing several projects at the same time is tough. When the environment changes from a static one to a more dynamic or uncertain environment however, managing multiple projects becomes even more challenging. Uncertainty is a daily issue with changing needs and planning of projects, not only having an effect on their own schedule but also on the
Increasing project management maturity in the ship repair industry

schedules and availability of resources for other projects (S. Collyer, et al., 2010). Prioritizing among projects becomes even more important and also more complicated. These aspects cause a lot of disturbances during the process and can trigger frustrations with general management, project management, line management and operations (Engwall & Jerbrant, 2003).

The models that have already been designed do not take project uncertainty into account (or to a limited extent). The research that comes closest to a multi-project management approach under uncertainty is the research done by Petit, who focuses not on the selection of projects in portfolio’s, but on the uncertainties in monitoring and control within them (Petit, 2012). His work provides insights in the difficulties in the multi-project management in this environment and a broad description on improvements. This limited basis for multi-project management under uncertainty calls for additional research. This has been mentioned by several authors for multi-project management (Engwall & Jerbrant, 2003; Jerbrant, 2014) and uncertain or dynamic environments (S. Collyer & Warren, 2009; Petit, 2012).

The research regarding dynamic environments has mostly been in the filming, IT and research industries. In this paper the focus lies on the ship repair industry. The main goals of this research are:

1. **Comparison of known project management approaches with the current project management approach in the ship repair industry**
   Provide insight in the management approaches that are currently used and the problems that can be identified. This will provide insight in the way the projects are managed at the moment and will shine light on which known management approach comes closest to current practices.

2. **Analyze if and how the known project management approaches can be implemented in the ship-repair industry**
   Through insight in the general characteristics of the projects. Uncertainty and dynamism focusses on the fact that the environments are unpredictable to a certain extent. To see whether this is true for the ship repair environment insight in the predictability of the projects is necessary. By predicting the outcomes of the projects, the project management is able to prepare for these outcomes, which changes the needed project management approach.

3. **Identify the dangers to the stability of the project management process**
   Identify the reasons behind the uncertainties and how the management of these uncertainties could be improved, using the knowledge gained from literature.

The research question that will be answered in this paper is therefore:

"Which problems occur in the management of non-standard projects executed in different ship repair-yards in a dynamic environment and how can these be overcome?"

This type of research has already been done in other environments and industries. For instance de Wit states that the measurement of project success can rarely be called objective and stresses the importance of audits (de Wit, 1988). Hamzah identifies causes of construction delay and makes a difference between concurrent, excusable and non-excusable delays (Hamzah, Khoiry, Arshad, Tawil, & Che Ani, 2011). Al-Momani tries to predict the delay in construction projects and their main reasons (Al-Momani, 2000), where Blismas identifies factors influencing delivery within construction multi-project environments and identifies four different categories of events (Blismas, et al., 2004). More in line with the uncertainty aspect is the research done by Drouin, who has identified 9 categories of unexpected events in complex projects (Drouin, Besner, Piperca, & Floricel, 2012). These researches have gone into an in-depth investigation of the matter. This research will focus on the broad perspective of the project management approach and will contain more than
only the causes behind increases and predicting delay.

Methodology

To obtain the goals that have been set a number of research methods have been used. Being interviews, data analysis of 40 projects and case studies. In Figure 7 a relation between the goals and the research methodologies has been illustrated.

The interviews have been held to inquire about the management approaches that are being used at the moment. These interviews have been conducted over several layers of management to get a comprehensive view on the environment and management approaches. The interviews had an exploratory nature and where set-up to increase insight on a broad level, rather than a deeper understanding of a single subject.

The quickscan has consisted of an analysis of 40 projects on (amongst other aspects) the planned and realised duration and costs. This quantitative analysis provides an objective perspective on the current management approach and confirms the conclusions that are made from the interviews. Together the interviews and quickscan provide a view on the current management approach and the predictability of the projects.

For a deeper understanding of a part of the environment, the case studies analysed three projects in-depth on the reason behind their escalation in scope, time and costs. These reasons are identified using a root-cause analysis and categorized using an Ishikawa diagram. The results from these three research methods are used as input to measure the project management maturity level. This tool provides guidelines for the implementation of project management at different levels of maturity. In this case it will measure the level at which the ship repair industry finds itself and suggestions will be given as to what needs to be done to improve that level. The main component of these suggestions is the project management approach. The project management maturity model of Kerzner has been used to measure at which level the project management approach currently is located and what this means for the future.

These three research methodologies provide answers to the sub-questions that aid the answering process of the main question:

1. To what extent are ship repair projects dynamic?
2. What is the current management approach regarding the large non-standard projects?
3. What should be improved in the management of the large non-standard projects?
4. What are the differences between the subsidiaries in their management and results?
5. What are the causes of changes of scope that bring about time and financial increase?

These questions will be answered throughout the paper, after their relevant results. The paper shows the results from the three methods of research; interviews, quickscan (data analysis) and case studies. These results have been used to make an implementation plan for the company, which is presented after the results. The paper concludes with the answer to the main question.
Results; interviews
The results from the interviews are summarized in this section. The overall conclusion that can be made from the interviews is that the project management level in this ship repair environment is very low. This makes it complicated to provide a management strategy that also takes into account the multiple locations and multi-project environment. These two aspects have therefore served as the general environment in the research, instead of specific aspects and consequences. Examples of what this has meant are the issues of projects that compete for resources, difficulties resource management (multiple locations) and efficiency benefits for large investments (multiple locations, these are present later on).

Management process
The results presented in the previous paragraphs provide a view on the project management process during the sales, execution and round-up phase. This view is presented in this paragraph.

A distinction can be made within the project phases regarding the involvement of the different managers. Sales management is generally involved in the first three phases (identify, define, plan) and project management in the last three (plan, execute, close-out).

This means there is an overlap in the planning phase. There is no clear consensus as to which who is or should be involved in each phase. An illustration of the process in the sales phase is presented in Figure 9, it shows that the scope is defined based on information from the client and (if possible)
inspections. This information is translated into a cost estimate and planning, which in turn has an influence on the decision of the client to change the scope. It also shows that the process is iterative and dynamic and requires a lot of attention and synchronization. Figure 10 shows the management process in projects during execution when a change occurs and is important for scope, time and financial management aspects.

Table 4 shows the aspects regarding the management process in its basic strategy, the strategies when changes occur and the complications that are related to the management aspect.

Evaluating projects is not done consistently or frequently. The necessity of the evaluations is present amongst the managers, however they indicate that there is not enough time or pressure from higher management to evaluate. Even when the evaluations are done, the results are not communicated and follow up is rarely given.

The combination of the aspects discussed in the interview results are the basis for a number of key observations that will be explained further. These have been identified by several interviewees and observed during the time spent at the company.

Large projects in-yard:
The non-standard projects take up a large amount of resources during their execution which puts a lot of pressure on the yards’ activities. The yard might have

Management process on changes

- What has been offered, is this part of the initial offer or is it a change?
- Communicate with the client (inform, offer, discuss)
- Why has it changed (it does not fit, wrong location, new unexpected work)
- Who is responsible for the change? (client, yard, subcontractor)

Figure 10 Management process on changes during execution to say no to (regular) clients which harms client-relationships. The other projects that are executed in the yard might be understaffed or de-prioritized because the large project can be a financially and strategically more important project.

The level of project management is currently not at a proper level to be able to handle the large non-standard projects. At the moment these projects are being managed as up-scaled small projects. However research shows that using consistent procedures regardless of project type and size is less successful than projects in which people have tailored their procedures. (H Payne & Rodney Turner, 1999).

Resources
Assigning resources to the projects is now done by a few people that prioritize the projects on a daily matter. There is room for improvement in using the resources more efficiently. Resource constrained scheduling tools or the critical chain method for MPE’s (Shu-Shun & Shih, 2009) could provide insight in the improvements that can be made or directions in which can be searched.

The current resource management strategy is effective because it enables adaptation to the demand at that moment. However it decreases the company knowledge (or diminishes the opportunity to learn), can cause less efficient productivity and the management of subcontractors provides room for improvement. The other option for increasing
Increasing project management maturity in the ship repair industry

Increasing capacity, working in overtime, also has its disadvantages. It decreases productivity and worker moral when it is used over longer periods. Workers create a negative atmosphere towards the management that is not willing to provide the staff needed to do the job, which is also confirmed by Payne (Payne, 1995).

Increasing capacity by subcontracting work also requires improvements. As a large organization the subcontractor can be persuaded to improve their process as otherwise other subcontractors might be hired. An interesting parallel industry that could be investigated to improve the collaboration with subcontractors is the automotive industry. These work together on a long-term contract basis with their suppliers in a highly committed relationship. Studies have shown that this has had a positive effect on the efficiency (Levine, 1992). If there are long term complications with the subcontractors or they are used on a high level basis, the consideration should be made to integrate the specific asset in the in-house process.

Planning
Planning is hard due to the unpredictable nature of the industry, the necessity of the planning is disputed amongst management. Traditional planning methods therefore might not be applicable to the ship repair environment, however there are many planning tools that focus on irregular or uncertain planning.

Scope changes are a common reason for the planning delays. It is hard to estimate what the scope is before-hand. It is essential to have a clear basic scope to which can be measured which changes have occurred and how these need to be measured or charged. It is not an option to stop the project until disputes over financial consequences or responsibilities have been solved as the vessel needs to leave.

There is no structured procedure of incorporating extra time “because delays always occur”, which might be interesting to see whether there is a general rule in amount of delay in the large projects (possible related to specific activities). This is done partly in the quickscan.

Project management approach
The final conclusion that can be made regarding the management processes is derived from the project complexity, points of attention and success factors. It provides a new view on an appropriate project management approach for the ship repair industry (Figure 11).

The priority in this aspect in general is time, but this is indirect. Time becomes the priority because of financial reasons. The client often chooses to favor time, because delays are more expensive due to their day-rate than speeding up the activities in-yard. In the end it comes down to a financial calculation from which spending more on an early finish is cheaper than a delay. The scope of the project is (to an extent) fixed at the start, however scope changes arise regularly, if not always. They are desirable, even though the scope changes cause increases in costs. In comparison with the traditional project management triangle and agile triangle, the time is the fixed aspect and costs and scope are variables (Figure 11).

Figure 11 Ship repair project management triangle (illustration designed by author)
Increasing project management maturity in the ship repair industry

The aspect of time is locked, as delays are less desirable than cost overruns. The projects generally run into scope changes, which is leading in the process. These changes are not undesirable as they can result in higher profits. Since the increase in scope must have an effect on one of the other aspects and the time is locked, the general consequence is an increase in cost. The whole triangle is overshadowed by the fact that safety must be taken into account in all decisions, as a second nature.

These priorities are mostly related to the execution phase, this is where the time is most important. The sales phase generally provides enough time to prepare as these are scheduled conversions and planned far in advance. This changes the approach for the sales phase. In the introduction the approaches of Traditional and Agile project management have already been described. The constraints of the TPM and APM approach are repeated in Table 5.

The underlined items are the flexible constraints. Based on the information provided from the interviews a guideline for the ship repair approach is given. This is presented in Table 6. The sales phase itself is anticipated to be quite stable. The scope is set and estimates on costs and time need to be given, which is similar to the TPM approach. Once the deadline is set it becomes very strict. During the execution time becomes leading, the scope changes and its consequences are solved in the financial constraint. Therefore the proposal is to prepare the projects with a TPM approach and execute the project with an Agile approach.

The applicability of dynamic approaches is discussed later on, since additional information is needed to be able to make a comparison between the dynamic and ship repair environment.

**Mother company**

The results from the part of the analysis related to the division has a lot of overlap internally. In different subjects several aspects reoccur. The outcomes have been summarized in the SWOT analysis illustrated in Figure 12. The general strength of being part of a larger company is the added support. In sales, finances and supporting functions there are more resources available than a single entity.

The opportunities show the potential, but they have not yet been reached. The support is mostly seen in the higher management level, but in the production

<table>
<thead>
<tr>
<th>Traditional project management</th>
<th>Agile project management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set budget</td>
<td>Set budget</td>
</tr>
<tr>
<td>Clear scope</td>
<td>Unclear scope, clear goal</td>
</tr>
<tr>
<td>Concise planning</td>
<td>Set time</td>
</tr>
</tbody>
</table>

**Table 6 Ship repair guideline**

<table>
<thead>
<tr>
<th>Sales phase</th>
<th>Execution phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set budget</td>
<td>Set budget</td>
</tr>
<tr>
<td>Scope clear to extent</td>
<td>Unclear scope, clear goal</td>
</tr>
<tr>
<td>Set deadline</td>
<td>Strict deadline</td>
</tr>
</tbody>
</table>

The underlined items are the flexible constraints.

![Figure 12 SWOT analysis](image-url)
this has yet to have an effect. Learning from each other in this area can provide efficiency benefits. The general improvement of collaboration, efficiency and more support can take the company to the next level. As well as one clear goal to make sure everyone has the same vision.

The weaknesses lie in the extra communication and coordination that is necessary to make sure the connection between the division and entity is made. In addition, the sales management is a strength, as it provides more support than could be available singular, however their distance from the yard causes inefficiencies and miscommunications. Lastly the entity has to make sure that it is profitable, however they have limited influence on the projects that are coming in. Also the sales managers that are located at an entity serve the interest of the division (a project might be placed better somewhere else) and the entity itself (the entity could use the turnover for their result).

The reputation of the mother company might benefit a subsidiary, but when this reputation is damaged by other parts of the company it becomes a threat. They can be associated with projects that they have had nothing to do with. Also the overview in the company can become limited and responsibilities fade. Issues might slip through the high load of aspects that need to be controlled or monitored.

The opportunities are aspects which can be benefited from if given attention. The weaknesses require attention because they can hurt the company interests if neglected. The threats must be monitored closely, because they can provide large problems.

**Subquestions 2 & 4**

*What is the current management approach regarding the large non-standard projects?*

At the start of the project the first step is to define the scope of the project. This is done based on information from the client and, if possible, inspections. From this scope the financial estimate and project planning are made. The feedback from the client on the estimated costs and planning often cause changes in the scope and therefore a change in the estimate and planning. It is an iterative and dynamic process that requires a lot of communication (Figure 13).

The earlier defined scope, estimate and planning is the basis for the execution of the project. During the execution phase when changes in the scope occur there are four steps that are taken. These can be found in Figure 14. The principle is to find out if it is indeed a change in scope or if it falls within the initial contract. If so, the consequences of the change must be communicated to the client as soon as possible. The reason why the change has occurred provides a basis to assess who is responsible for the change and thus accountable for its consequences.

![Change management process](image)

**Change management process**

- What has been offered, is this part of the initial offer or is it a change?
- Communicate with the client (inform, offer, discuss)
- Why has it changed (it does not fit, wrong location, new unexpected work)
- Who is responsible for the change? (client, yard, subcontractor)
The results have shown that during the project in the decision making process certain priorities are given. In traditional project management when a project is executed there is a balance of time, scope and costs. However, in this situation it is different. Time is of the essence as often penalty clauses are included in the contract. The client needs to leave at a strict date to continue work and minimize downtime of the vessel. The scope changes occur in all projects, which is not a negative aspect as such, because most scope increase provides more profit. If the scope changes, one of the other aspects needs to change as well, either the project has to take longer to execute the work or more money needs to be invested to fit the scope changes in the planned duration. As the increase in time is in most cases not an option, the costs become higher. In addition, all work, being the assigned work from the contract or extra work, must always be executed in a safe way.

What are the differences between the subsidiaries in their management and results? The four subsidiaries taken into the research do not point out specific differences in management approach. However the results from the data analysis show that there are differences between them. Especially in the size of the projects (financially and in duration) the locations differ. The results have also shown that the risks taken at the start of a project vary as well. Two locations have a habit of taking on projects with a negative result on estimation, then turning the result around to a positive one in the end. While one of the locations continuously manages to keep the actual project result the same or lower, even if the projects’ scope increases. Which generally means that the profit should increase. This shows that the project control in this location should be improved. These results are useful in the decision where to execute a project. Not only do their resources vary, which is one criteria for locating a project, but their results should be taken into account as well.

In general, being a part of a larger company provides the following advantages and disadvantages:

On the **positive** side:
- Increased knowledge
- More overhead support
- More power in the market
- Increased services and resources available for the client
- The reputation of the overall company enhances the reputation of the individual

On the **negative** side:
- Decreased overview of all company activities
- Responsibilities fade
- The reputation might harm the individuals’ reputation
- Serving two interests
- Geographical distance, more effort needs to be made to keep in contact

**Results; Quickscan**
The results from the quickscan has provided insight in the general course of the projects. The following summary can provide a starting point when starting a non-standard project, to predict what can happen with its result. The statements given vary in their validity, the statements that need more data to be valid to be given a value are addressed with a *.
**Time**
The average delay in duration in the projects can be taken from 140% to 155%. These are the median and average value. A range is given because the median value would be too low and the average value would be too high.

As the turnover on projects become larger, the variation in the increase of duration becomes smaller. These could be more stable in the increase of execution time.*

**Cost price and turnover**
The turnover and cost price of a project always rise due to extra work. Similar to the time increase in this case a range between the median and average value is given to estimate the increase in cost price and turnover. The cost price ranges between 185% to 226%, the turnover ranges between 171% and 256%. The turnover is less predictable as it depends on the causes behind the increase and the willingness to pay of the client.

Similar to the increase in time the cost price and turnover becomes less varied as the turnover of the project becomes larger*.

The age of a vessel can be of influence on the project result. Older vessels tend to increase more in turnover and cost price* which might have two reasons:

- Estimation processes on newer vessels are more accurate, therefore the difference between estimate and actual result becomes smaller
- Older vessels cause more unexpected extra work

**Project result**
The project result and its variation can be estimated based on their normal distribution. The project result varies from -5% and 34%. This variation is very large, which decreases its value of predictability. This is also the case for the increase of the project result in %, as this value ranges between -25% and 39%. Even though it is a large range, these results can be used in predicting a worst-case and best-case scenario at the beginning of a project.

The estimated percentage of project result varies less when the turnover from a project becomes higher*. This means that the calculated percentage of project result has a high chance of remaining the same. This is also true for the duration of the project. As the execution time becomes higher, the estimated project result remains the same (or increases slightly)*.

**Internal and external work**
The results show that the internal work of the project decrease in larger projects, however it also shows that higher profits are made in projects that escalate and execute this work internally. Which is why the goal should be that when increases of scope occur the work should be done internally instead of externally, as this provides the highest results.

**Locations**
The decision as to where to execute the project can be influenced by the past results of a yard. Also the decisions about a yards’ future can be made based on the projects that have been executed.

Rotterdam and Vlissingen handle longer projects than Brest and Amsterdam. Vlissingen also executes the largest projects financially. Which means that they handle large projects in the same amount of time (approximately) that Rotterdam does. Also Rotterdam and Vlissingen take on more high-risk projects, starting out with a negative project result and turning them around to a positive project result.

Brest has, on average, a lower increase in project turnover than in cost price, which means that their actual project results decreases instead of increases from estimate to actual. Also their ratio between internal and external work is smaller, they outsource more work to subcontractors. This is a direct link, even though it is a small difference, as the previous results has shown that more profit is made on internal work. This is a sign that something in the
management of their projects is being done different than the other locations.

**Results; case studies**
The case studies have resulted in a number of causes regarding scope changes. These have been analysed using a so called Ishikawa diagram, which can be found in the appendix. The Ishikawa diagram divides the causes in six categories, the most causes have been identified in three of the categories. These three categories are discussed here. Also the relation between the predictability and desirability of the changes is presented.

The management, materials and methods/processes have the most input in the diagram and contain most of the items that have been a cause for discussion in the negotiation in the end. Within these categories some items are related, the other three categories contain unique events that require more effort to anticipate or manage. For quick wins in improvements of the process around scope changes, the focus should therefore lie within these three categories. On the long term, the other categories could be of interest as well.

**Materials:**
The materials contain the vessel itself and the materials that are being used to execute the works (not the equipment). Four of the causes within this category are directly related to the state of the vessel. In two cases the age of the ship caused several issues with the state of the steel, which wasn’t anticipated on. One case related to the base layer of the ship which was of a lower construction quality. The last had been the assumption that the ship was exactly symmetrical, which was not the case and a crane that got damaged during the upgrade of new parts.

It is interesting to see that none of these aspect has been a cause of discussion. From the analysis it resulted that these items, especially related to the state and age of the vessel, are generally accepted by the client. They tend to anticipate on a certain level of uncertainty in the state their vessel.

*Solutions within this cross-case analysis related to:*  
- Measurements  
- Steel quality  
- Age anticipation

**Methods/process:**
Within the methods and processes a lot of the causes are related to information, which has also come up in the interview results earlier. The knowledge on what equipment is going to be installed, details on how the works will be executed, incomplete information and lack of knowledge on the works all have had their share in scope changes. Another item has been a higher standard in safety, steelwork and functioning equipment. The last one is preparation, which also has been an aspect that has been mentioned earlier.

*Solutions within this cross-case analysis related to:*  
- Preparation  
- Information management  
- Setting higher own standards/assess client standards in advance

**Management:**
The most aspects that have been subject to discussion came from the management category. These where especially related to differences in expectations regarding to responsibilities and interfaces, related to the client and subcontractors. Another large cause is the fact that activities are estimated with a certain commercial basis, to improve the odds on booking the project. These have caused financial increases in two of the cases and has also been mentioned earlier in the interviews. They can be expected, almost guaranteed even. The client sometimes brings his own subcontractor, or the constructor that has built the ship needs to execute work on the vessel as well. In two instances this has been a cause for scope change, where either the subcontractor or contractor failed to perform. In this case the yard executed the work.
Solutions within this cross-case analysis related to:
- Contract management
- Process management
- Estimation processes

Desirability vs. predictability

In the cause-and-effect diagram can be seen that the scope changes often result in a positive contribution to the project result. In an ideal situation, one wants to know which scope changes contribute positively to the profit of the project and which scope changes contribute negatively to the profit of the project. The tables in this section illustrate the causes behind each scope change and its accompanying predictability (−, + and ++). Also the scope changes are given a colour to indicate whether they have had a positive or negative result on the project result.

These three tables provide a view of the causes and their predictability. These causes have been generalised and are displayed in a matrix between their predictability and desirability (potential for profit). If a VOR is stated to be undesirable it does not mean that this should be ignored completely, but is a case that should be handled internally, for internal anticipation.

1. VOR’s that cannot be foreseen but could improve the project
2. VOR’s that can be foreseen and could improve the project
3. VOR’s that cannot be foreseen and could harm the project
4. VOR’s that can be foreseen but would harm the project (would be kept internal), otherwise the offer towards the client would be much higher, which means the projects would not be booked.

The first quadrant are items that are hoped to happen (Figure 16). The second quadrant are items that can be steered towards. The third quadrant are items that one hopes not happen. The fourth quadrant are items that items that should be prevented.

Subquestion 5

What are the causes of changes of scope that bring about time and financial increase?

The analysis of the causes shown in the cause-and-effect diagram have been generalized into six categories.

- Equipment
- Methods/process
- People
- Materials
- Environment
- Management

A high number of causes within the cases have been found in the highlighted categories. These results are not generalizable to all projects, however they provide a basis for further research in this area and emphasizes the need for better management practices. A large part of the causes have shown to be predictable. Therefore the focus for improvements in the management of changes in scope lie in predicting the changes of scope.

The majority of the causes have shown to be the result of aspects within the project; internal aspects. Whether it is the client, the subcontractors or the yard, the most scope increases are caused by internal parties.
Increasing project management maturity in the ship repair industry

Project management maturity

The results presented earlier provide insight in the ship repair environment, the current management approach used, what problems arise during the projects and which causes lie at the root of these problems. The combination of the results show that the project management expertise in the ship-repair environment varies greatly. To clarify on which level the current project management approach is, the results from the research has been used as input for the project management maturity model (PMMM) by Kerzner (Kerzner, 2002). This provides guidance as to how the results from the research can be used to improve the project management process. This part consists of an introduction of the project management maturity model, the contents of the first two levels for the ship repair industry and implementation and recommendations for the future.

Model

The project management maturity model by Kerzner consists of five levels which all represent a different degree of maturity in project management. The levels are illustrated in Figure 17. There is overlap possible between the levels, however not between all of them. Level two and three for instance generally do not overlap as in levels one and two a methodology is developed and in level three this methodology is adopted. For this paper, only the first two levels are described, as the three levels above are not (yet) relevant for this company.

In the first level, the organization recognizes the importance of project management and the need for a good understanding of the basic knowledge on project management and the accompanying language/terminology. At level two the organization recognizes that common processes need to be defined and developed such that successes on one project can be repeated on others. The basic principle to overcome level one and grow towards level two is education on project management principles, the (dis)advantages of project management and the basic language of project management (Kerzner, 2002). The characteristics from both levels are summarized in Table 7.

Current PMMM level

The interviews have shown that there is some level of project management being used in the projects. However the application of project management is done on a personal note and everybody uses their own process. The information systems used are the same within the yards itself, but each yard in the company has its own system. The support for project management exists on a low level but is not a high priority item on a daily basis. The support and interest in project management can be explained because the ship repair industry is project-driven. The core business is executed in projects, other...
Increasing project management maturity in the ship repair industry

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Level 1 “Common language”</th>
<th>Level 2 “Common processes”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support</strong></td>
<td>If the organization is using project management at all, the use is sporadic. Both senior management and middle-level management provide meaningless or “lip” service support to the use of project management. Executive-level support is non-existent.</td>
<td>Project management must be supported throughout all levels of the organization, including the senior levels. It is possible that changes to the corporate culture may be necessary, thus mandating executive support.</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>No attempt is made to recognize the benefits of project management. Managers are worried more about their own empires, power and authority, and appear threatened by any new approach to management.</td>
<td>Tangible benefits of using project management must become apparent. The most common benefits include lower cost, shortened schedules, no sacrifice of scope or quality, and the potential for a higher degree of customer satisfaction.</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>There exists no investment or support for project management training and education for fear that this new knowledge may alter the status quo.</td>
<td>The final characteristic of level two is the development of a project management curriculum rather than just a project management course. This is often seen as proof of the organization’s firm commitment to project management.</td>
</tr>
<tr>
<td><strong>Interest</strong></td>
<td>There may exist small “pockets” of interest in project management, with most of the interest existing in the project driven areas of the firm.</td>
<td>A continuous stream of successfully managed projects requires methodologies and processes that can be used over and over again. This requires an organizational commitment.</td>
</tr>
<tr>
<td><strong>Decision making</strong></td>
<td>Decision-making is based upon what is in the best interest of the decision-maker, rather than the firm as a whole.</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Cost control</strong></td>
<td>N/A</td>
<td>Managing projects within scope and time is only part of the effort. The projects must also be completed within cost, and this may mandate changes to the cost accounting system.</td>
</tr>
</tbody>
</table>

Table 7 Characteristics first two levels PMMM (Kerzner, 2002)

departments than the sales and project management are supportive to the projects. Attempts are made to recognize the benefits of project management in the organization, for instance the implementation of a new information system technology is currently being executed. Decision making within the project is based on what is best for the project itself. The education and support from upper management for project management is outside of the scope of this research. This could be measured by conducting reviews on the opinions of project management regarding project management support and an inquiry of the possibilities and use of educational facilities that are offered. To advance towards level 2 the following advancement criteria are given:

- Arrange for initial training and education in project management
- Encourage the training (or hiring) of certified project management professionals
- Encourage employees to begin communicating in common project management language
- Recognize available project management tools
- Develop an understanding of the principles of project management

Where the focus in the first level lies on education, the fact that education has been given does not guarantee that project management is used in an organization, let alone effectively. In level two the organization needs to make a unified effort to use
Increasing project management maturity in the ship repair industry

project management and develop processes and methodologies to support its effective use. At the moment the organization realizes that these are needed so that managerial success on one project can be repeated on other projects. The benefits of the use of project management are apparent in the organization, however benefits of a common project management approach are not yet available. The support from executive management is outside of the scope, but this research is an example of the recognition of the necessity for change (although it is not visible support).

This maturity model states that the projects should be completed within scope, this is not the case for this industry, in which scope changes are desirable. Scope change recognition nevertheless requires a specific cost accounting system. Again, this is available in yard but it differs between yards.

The advancement criteria towards level 3 are:

- Develop a culture that supports both the behavioral and quantitative sides of project management
- Recognize both the driving forces/need for project management and the benefits that can be achieved in both the short and long term
- Develop a project management process/methodology

The part that covers the part of the process that needs to be executed by the executive level is shown in Table 8. It is clear that only the cost control aspect (which does not exist in level 1) is the only part that reaches level 2. The other aspects require additional work to complete level 1 to continue towards level 2.

The theme of level 1 is creating a common language in project management. This requires effort in two sides of project management. On one hand in selecting a project management approach and on the other hand educating people in this approach. Figure 18 shows the current status of project management understanding. The aspects that have been incorporated in the figure are selected from the PMBOK approach (PMI Inc & Chapter, 2009). At the moment the greater part of the projects is managed in improvisational ways. The managers have come up with personal systems to deal with the projects, there is no consistent manner in which the projects are managed. The goal is to upgrade the knowledge on the aspects at least to an “understanding” level, so everyone knows what they are talking about. Some of the aspects will be upgraded towards an aligned methodology, which is be the same for every yard. The “understanding” level can be linked to level 1 of the PMM, the “aligned methodology” level can be linked to level 2 of the PMMM.

The scope estimation is based on the clients offer and documented, each yard in their own way. The problem with the scope is that the basis scope is often not well documented or defined, which provides difficulties but also opportunities. The client can argue that the increase of work was part of the

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td></td>
</tr>
<tr>
<td>Executive support exists, but is not visible</td>
<td>-</td>
</tr>
<tr>
<td>Benefits</td>
<td></td>
</tr>
<tr>
<td>Steps are taken to get insight in the projects’ results</td>
<td>-</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Non-standard</td>
<td>-</td>
</tr>
<tr>
<td>Interest</td>
<td></td>
</tr>
<tr>
<td>Interest in PM exists, mostly in execution</td>
<td>-</td>
</tr>
<tr>
<td>Decision making</td>
<td></td>
</tr>
<tr>
<td>Based upon what is in the best interest of the project</td>
<td>N/A</td>
</tr>
<tr>
<td>Cost control</td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>System is at high level, but type varies per location</td>
</tr>
</tbody>
</table>

Table 8 Current status PMMM
original scope, which limits the option to transfer the additional costs toward the client. Time management has also proven to be a problem, while it is the most important constraint of the industry. The project is often planned (to a certain extent), but often not updated and sometimes completely discarded. However, cost management is done quite well. The cost overviews are updated regularly and in a detailed manner, (often) by a designated cost controller. Still, the cost control system differs per yard and in its level of detail. The project handover from sales to project management is currently done in an unstructured way, ranging from non-existent to the handover of files without any explanation. There is a lot of misunderstanding between the sales management and project management. Especially on the low and unrealistic estimations (according to project management) and the commercially needed offers (according to sales management). Evaluations are not held consistently and structured. There appears to be no time and no clear responsibility for doing the evaluations. Besides, the results are not communicated or followed-up. However a new system is currently being designed and integrated over all yards in which quantifiable data about the projects is documented. These results make the projects comparable and provide insight in where the projects need to improve.

Project management approach for implementation

The previous section has described the current level of project management maturity and also the advancement criteria towards the next levels. In this section, three of these advancement criteria are described. The first two criteria are needed to advance from level one to level two. The last criteria is to advance from level 2 to level 3.

1. Develop an understanding of the principles of project management
2. Recognize available project management tools
3. Develop a project management process/methodology

These three criteria are filled in using the results from the previous research. The other criteria are organizational changes that need to be implemented and are described in the following section.

Level 1 Common language

The common language that is suitable for the ship repair environment and necessary to develop an understanding of the principles of project management consists of the ship repair triangle, the project prediction and quick wins. The quick wins have the added benefit that (when implemented) they can show the first benefits of project
management that is needed to gain support and interest for the implementation of the project management approach. The section concludes with project management tools.

**Triangle**
The priority in the project management process in general is time, but this is indirect. Time becomes the priority because of financial reasons. The client often chooses to favor time, because delays are more expensive due to their day-rate than speeding up the activities in-yard. In the end it comes down to a financial calculation from which spending more on an early finish is cheaper than a delay. The scope of the project is (to an extent) fixed at the start, however the scope changes arise regularly, if not always and are desirable. The scope changes cause increases in costs. In comparison with the traditional project management triangle and agile triangle, the time is the fixed aspect and costs and scope are variables (Figure 19).

The aspect of time is locked, as delays are less desirable than cost overruns. The projects generally run into scope changes, which is leading in the process. These changes are not undesirable as they can result in higher profits. Since the increase in scope must have an effect on one of the other aspects and the time is locked, the general consequence is an increase in cost. The whole triangle is overshadowed by the fact that safety must be taken into account in all decisions, as a second nature.

**Predicted project outcome**
Anticipating on the outcomes of the projects allows for more flexible (internal) estimations and planning. It also shows sales and project managers where the project is likely to result in which manages their expectations and understanding of the projects. The outcomes of the projects are given in Table 9.

**Quick wins**
In preparation of the projects a number improvements on anticipations and preparations can be made on the process of the project. The first is on materials, the second on the methods and the third on management.

**Materials**
- The quality of the steel varies per vessel, more thorough inspections improves the estimations of the amount of work on steel.
- The information that has been provided (either by the client or the engineering company) on the measurements of the vessel should be viewed more critically. This prevents surprises during the installation of material and equipment.
- Anticipate on the age of the vessel. In general older vessels run into more extra work than younger vessels. This can be combined with more thorough inspections on the steel work as it is often the steel work on older vessels that has deteriorated.

**Methods:**
The information provided by the client is often limited. Within the management more assertiveness is needed to make sure more information comes to the table or it needs to be communicated and recorded that the information is missing or limited. A more rigorous preparation process will also improve the process on the provision of information. A specific aspect that requires improvement or a more assertive attitude is the standards that are being used in the projects. Especially the large projects bring clients that require higher quality and safety...
Increasing project management maturity in the ship repair industry

standards than usual. At the moment the standards from the clients are leading but there is often much vagueness amongst the standards. Being more assertive on the contents and consequences of these standards will diminish surprises along the way. In the long haul the company’s own standards can become higher, to prevent dependence on the client.

Within the methods and processes a lot of the causes are related to information, which has also come up in the interview results earlier. The knowledge on what equipment is going to be installed, details on how the works will be executed, incomplete information and lack of knowledge on the works all have had their share in scope changes. Another item has been a higher standard in safety, steelwork and functioning equipment. The last one is preparation, which also has been an aspect that has been mentioned earlier.

**Management:**

- The changes in the execution phase are at the moment disputed because of discussions on responsibility and whether the change was part of the original contract or not. Hiring a dedicated contract manager on these projects and in the long haul educating own personnel on contract management will improve this point of frustration
- The interfaces in the projects provide difficulties and lack of overview that the project manager is not able to manage. Placing a dedicated process manager next to the project manager on these projects makes sure there is a person responsible solely to the process and the stakeholders.
- The project-handover needs to be improved. The sales and project manager need to dedicate more attention to communicating the decisions made in the sales phase, possible pitfalls and the offer that has been made towards the client.

**Project management tools**

The last aspect to improve the first project management maturity level is the tools and systems that are made available to the project managers. The tools that can be implemented (and partly already are implemented) can be found in Table 10. A difference has been made between the difficulty in implementation and use of the tools. At this moment the project management strategy has a reactive nature. The reactive strategy aims at “generating the best possible reaction to a disturbance that cannot be absorbed by the plan without changing it” while the proactive tries to “alleviate the consequences of uncertainties prior to the start of the project, e.g. by allocating the flexibility in a plan to uncertain activities, or to the periods where there are uncertainties” (Hans, Herroelen, Leus, & Wullink, 2007). As the results from the cases have shown that some causes behind the scope changes can be predicted, an upgrade to proactive approaches could improve the project management process.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Variation</th>
<th>from:</th>
<th>to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td></td>
<td>140 %</td>
<td>155 %</td>
</tr>
<tr>
<td>Cost price</td>
<td></td>
<td>185 %</td>
<td>226 %</td>
</tr>
<tr>
<td>Turnover</td>
<td></td>
<td>171 %</td>
<td>256 %</td>
</tr>
<tr>
<td>Project result (in % of turnover)</td>
<td></td>
<td>-5 %</td>
<td>34 %</td>
</tr>
<tr>
<td>Project result increase (in %p)</td>
<td></td>
<td>-25 %p</td>
<td>39 %p</td>
</tr>
</tbody>
</table>

**Larger projects have less variation in their time increase**

**Larger project have less variation in their increase of cost price and turnover**

**Cost price and turnover on older vessels tend to increase more than younger vessels**

**Projects with higher estimated turnover have less variation in project result**

**Projects with a longer duration have less variation in project result**

Table 9 Predicted project outcome
Increasing project management maturity in the ship repair industry

Level 2 Common processes

The second level is mostly focused on generating the right approach for project management. The interest and understanding of project management is (being) acquired and it is time to develop processes and methodologies to support its effective use. This common process is presented in this section. It begins with an approach based on the traditional and agile project management approaches, supplemented by approaches from theories on dynamic project management. Additionally a set of project management tools is proposed that are suitable for the ship repair environment. The choices made in this section are based on the results from all three parts of research. A theoretic model based on the Delft systems approach for the execution phase of the projects has already been made recently and provides insight in the information flows and interfaces across management levels (Veeke, Ottjes, & Lodewijks, 2008; Wiskerke, 2015). Finally a risk strategy is necessary for the common processes. The quick wins from the case studies have already been taken into the common language, but more detailed approaches on the risks that arise during the projects can be made from the case results.

Towards a management approach

The interview results have shown that the environment of the ship repair industry requires a different project management triangle than the traditional or agile triangles. This doesn’t mean that certain aspects of the TPM or APM methodology are not applicable for a ship repair project management methodology. Based on the research done in the interviews and the case studies, the recommendation that is made here is to prepare the project in a traditional manner and continue to execute the project with an agile approach. This provides a sound basis to start from and provides the necessary flexibility in the execution phase. The underlined items are the flexible constraints. This is presented in Table 11. The sales phase itself is anticipated to be quite stable. The scope is set and estimates on costs and time need to be given, which is similar to the TPM approach. Once the deadline is set it becomes very strict. During the execution time becomes leading, the scope changes and its consequences are solved in the financial constraint.

Another field from which approaches can be adopted is the field of dynamic project management. This is described as “A dynamic project environment is taken to mean one in which there are high levels of change in anything the project is dependent on. This is usually an environment where the proportion of unknowns at the start of a project is high, and the amount of adaptation required as the project progresses is high. A dynamic project is one that is necessarily subject to significant change as it progresses, due to rapid changes in the environment in which the project is conducted. Dynamism is linear, not binary. The change has to be rapid because otherwise it can be dealt with using normal change management processes, that are part of traditional project management. It’s a matter of degree.” (Collyer, 2008) This definition is true for the ship repair sector to a certain extent. The dynamic environment for which it is designed are research and design projects, these projects run into a lot of

<table>
<thead>
<tr>
<th>Category</th>
<th>Reactive</th>
<th>Proactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope management</td>
<td>Improved contract management to fix the basis scope and identify increases</td>
<td>Estimating of possible scope increases based on historical data</td>
</tr>
<tr>
<td>Time management</td>
<td>Gantt chart</td>
<td>Probabilistic planning, PERT</td>
</tr>
<tr>
<td>Cost management</td>
<td>Basic administration and overviews</td>
<td>S-curve analysis, prognosis</td>
</tr>
<tr>
<td>Risk management</td>
<td>Risk register</td>
<td>Monte Carlo analysis</td>
</tr>
</tbody>
</table>

Table 10 Tools and systems

Table 11 ship repair project management guideline
Increasing project management maturity in the ship repair industry

change during execution, however these changes are of a different nature. Where in the ship repair sector the changes are caused by clients’ desires, mistakes in the design or engineering, delivery times, state of the vessel and other (both) internal and external influences. The changes in the dynamism field are mainly from external sources. The rapid change of technology in science projects for instance. Therefore this approach cannot be applied one to one in the ship repair. Table 12 shows the management approach in dynamic environments and if they are applicable to the ship repair industry.

For a detailed project management approach further research is necessary. The distinction of approaches between the sales and execution phase can be used as a starting point. Education on this distinction can already commence as a general understanding of both approaches is required in order to understand a more detailed approach.

**Risk**

The implementation of upper mentioned changes is not without risk. The ship-repair industry is known to be conservative and resistant to change. The risks that are identified by Kerzner with level one and two are:

- Fear of organizational restructuring; since the company is project-driven, the organizational restructuring will probably not be very rigorous. The risk of this aspect therefore is low.
- Fear of changes in roles and responsibilities; since there are people nominated to be educated in the large projects, this might cause jealousy amongst other project and sales managers. Openness and the possibility to apply for the education program could decrease this risk.
- Fear of changes in priorities; much visible attention will be given towards the large non-standard projects. This might cause dissatisfaction in the part of the company that manages the smaller projects. Good communication and equal interest towards

<table>
<thead>
<tr>
<th>Dynamic approach</th>
<th>Applicability to ship repair industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment manipulation - making dynamic static</td>
<td>Not applicable, it suggests to reject changes which goes against the business model of the industry</td>
</tr>
<tr>
<td>Planning approaches for dynamic environments</td>
<td>Limitedly applicable, the goal of the project is clear and the method also. So a more detailed planning is possible</td>
</tr>
<tr>
<td>Scope control for dynamic environments</td>
<td>Applicable, it proposes that components of the projects less subject to change can be run using a more detailed planning approach, and components subject to higher change using the learning approach.</td>
</tr>
<tr>
<td>Controlled experimentation</td>
<td>Applicable, new technologies, management strategies and logistics could be tried out to improve the execution of ship-repair projects</td>
</tr>
<tr>
<td>Lifecycle strategies</td>
<td>Limited applicability, it is mainly focused on the iterative nature on design and research projects. However the build-in of flexibility can be applied to be prepared for changes</td>
</tr>
<tr>
<td>Management controls: input, behavior and output, diagnostic, belief, interactive and boundary</td>
<td>Applicable, the team managing the project and their behavior and motivation can improve the process</td>
</tr>
<tr>
<td>Culture and communication for dynamic environments</td>
<td>Unknown, the scope of the research excluded the culture and communication in the organization, therefore no judgment can be made in this matter</td>
</tr>
<tr>
<td>Categorization</td>
<td>Applicable, the types of projects and processes related to it can be tailored to their specific needs.</td>
</tr>
<tr>
<td>Leadership style</td>
<td>Applicable, the project manager and its ability to be flexible and have a hands on approach might be valuable to the overall project result</td>
</tr>
</tbody>
</table>

Table 12 Project management for dynamic environments (Collyer & Warren, 2009)
both parts of the company could decrease this risk.
• Resistance to a new methodology; the risk on introducing a new methodology is medium. The pressure on the project team is currently very high, therefore ways to decrease this pressure will probably be embraced. The ship repair industry however is a rather conservative industry, therefore change in general will bring risk of resistance. Participation in the implementation program could decrease the resistance.

The time period to complete level 2 is usually six months to two years depending on type of company, visibility of executive support, strength of the corporate culture, resistance to change, speed with which a good methodology can be developed, existence of an executive-level champion to drive the development of the project management methodology and the speed with which the project management benefits can be realized. (Kerzner, 2002)

**Future; levels 3 through 5**
After completing levels one & two and thereby reaching level three, a basis has been set regarding project management. Level three consists of further aligning the project management tools and processes and involving the other management departments of the company into that process. Since the company is project-driven this is already partly implemented, but it requires improvements. Level four is focused on benchmarking, deciding whom and what to benchmark. The benchmarking done in level four will result in improvements executed in level five, which in its turn will reflect on the singular methodology created in level three. These levels will continue to iterate to keep improving the project management approach and strategy. A sound basis for this process is the establishment of a project management office that is responsible of continuous evaluation and improving of the project management processes.

**Subquestion 1 & 3**

**To what extent are ship repair projects dynamic?**
A dynamic environment has been classified as one where high levels of change arise in anything the project is dependent on in its environment. The proportion of unknowns at the start of a project is high, the amount of adaption required as the project progresses is high as well and significant changes arise. As project dynamism is linear and not binary, it cannot be classified as either static or dynamic but can lean towards one of the sides.

The projects taken into account have been subject to large changes during their cycle that have required significant adaptations in the process. The projects have a general outline at the start but still a high level of unknowns are present before execution. These aspects show that the characteristics identified with dynamic environments are present in the ship repair industry. The dynamic project management approach has however been made for design and research projects that run into changes in its (primarily external) environment. The difference between the ship repair industry and the industries for which the dynamic approach is made lies in the fact that in the ship repair industry the changes are from both internal and external influences. Therefore the characteristics of the ship repair industry and dynamic environment correspond, however the causes behind the characteristics differ and the ship repair cannot simply be classified as a dynamic environment.

**What should be improved in this management of the large non-standard projects**
The management process shown earlier has implications on the challenges faced in projects. The projects can be predicted to a certain extent and with a limited range. The range however is very large so the question remains as to how much practical relevance it has. What also can be done is improve the ability to predict changes and therewith being able to prepare for what might come. Implementing a project management methodology that is tailored
Increasing project management maturity in the ship repair industry

29

for the ship repair industry, based on a mix of Agile, traditional and dynamic project approaches provides improvements. The general level of project management needs to be up to a level two in the project management maturity model by Kerzner. If the project management level is not up to this standard, improving the management of these projects is very difficult and requires more effort.

The projects should be prepared in a traditional manner and executed with an agile approach. This provides a sound basis to start from and provides the necessary flexibility in the execution phase. The underlined items are the flexible constraints in Table 13. The sales phase itself is anticipated to be quite stable. The scope is set and estimates on costs and time need to be given, which is similar to the TPM approach. Once the deadline is set it becomes very strict. During the execution time becomes leading, the scope changes and its consequences are solved in the financial constraint.

Even though the ship repair environment is not identified as dynamic, the approaches that are used in dynamic project management can (to an extent) be used in the ship repair industry (Table 14).

The combination of predicting a projects result and duration and predicting changes that could arise would turn the project management approach into a proactive approach.

<table>
<thead>
<tr>
<th>Sales phase</th>
<th>Execution phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set budget</td>
<td>Set budget</td>
</tr>
<tr>
<td>Scope clear to extent</td>
<td>Unclear scope, clear goal</td>
</tr>
<tr>
<td>Set deadline</td>
<td>Strict deadline</td>
</tr>
</tbody>
</table>

Table 13 Ship repair project management guideline

Table 14 Project management for dynamic environments (Collyer & Warren, 2009)
The research subquestions stated earlier have been the basis for the research conducted. These questions have been answered to answer the main research question:

“Which problems occur in the management of non-standard projects executed in different ship repair-yards in a dynamic environment and how can these be overcome?”

The main problem that has been identified is that the projects run into scope changes during their execution. These scope changes put pressure on the project itself and on the rest of the yard as the projects have to share resources. The changes cause cost overruns and delay in time. However, delay in time is unwanted because the client wants to minimize downtime and the yard has other projects lined up. The delays are minimized by investing in additional resources and man-power which increases the costs.

“Scope is leading, time is a hard boundary, costs are a variable”

This statement might lead to the conclusion that the scope changes need to be prevented. However the added work provides more profit for the company, as extra work has shown to have a higher profit. Therefore it is necessary to improve the ability to predict project costs and duration and scope changes so the preparations regarding the consequences can be improved.

“Controlling scope changes, not preventing them”

A part of the scope changes can be predicted or foreseen. Investments in the general level of project management on large non-standard projects is a necessity. The level of project management maturity needs to be on a proper level to be able to handle the scope changes in general without putting large pressure on the project team. Only after this base level has been acquired it is possible to implement more complex project management tools and systems.

“Improve the basis of project management before implementing advanced project management tools and systems”

Recommendations

Further research

These conclusions have followed from a research executed in one ship-repair company. The results therefore need to be verified to say that the results have generic value. A comparable study in other ship-repair yards can provide further confirmation. Within the (ship) repair industry the results are expected to be comparable. The state of the delivered materials is hard to estimate, whether it is a ship, a car or an airplane. The time aspect of this industry might be unique in comparison with other industries. Therefore further research is necessary both in other repair industries, as well as other dynamic environments.

The ship repair triangle now only included time, costs, scope and safety. Other aspects that have been included in other triangles were out of scope in this research but might have an interesting impact on the triangle. Such aspects could be the client interests and impact.

The trends identified in the quickscan need further research before any values can be given to the predictability of these trends. They could improve the predictability of the projects outcome greatly.

An expert meeting with practitioners and/or expert from the theoretical field is necessary to validate and reflect on the results from the research. The practical implications should be reviewed by practitioners. The theoretical set-up and conclusions by theorists that are experienced in the field.

Damen

To improve the data for the project analyses the data collection process should be improved. At the moment the data is generated from project administration that needs to be collected from storages and this differs per yard. One general data collection system that needs to be filled out with
certain boundaries makes the data collection easier and more consisted. This can be of great worth in the future, to analyze the project results over time.

The results from the fourth yard show that the management approach in that yard is different and in need of improvement. This was not possible in this research, however further research regarding the project management process in this yard can improve its project results.

The educational aspect and the support from executive management that is important in the execution of the project management maturity model needs to be researched before the plan can be finalized and carried out. Also in the implementation of the plan a lot of attention is needed on the way it is implemented. The changes that it brings with it can be resisted by employees so a more elaborate change management plan is necessary.

Limitations and reflection

**Interviews**
The results from the interviews might have been more precise if a more structural plan would have been made before-hand. In hindsight the PMBOK guide could have been used to develop a structured and more comprehensive guideline to include all topics. For instance, what has shown to be an important factor in the research is risk analysis, however this has not been included in the interviews, therefore the recommendations on this part is limited.

**Quickscan:**
The yards differ in their calculation of overhead costs. Therefore the use of cranes or other facilities might be taken into the project costs in one yard and into the overhead costs at another. It has not been possible to eliminate these factors from the analysis and this might change the outcomes.

Estimations and offers are made on a certain scope, that often changes as soon as the project is accepted. This scope is not registered at that time so the used value in the quickscan of the estimate might be misleading. It is possible to calculate that value by deducting the value of the VOR’s from the turnover, but then the cost price would not be known. Therefore the decision has been made to work with this data.

The analysis has been executed on 40 projects. For a statistical basis this is a low amount of data. Additional data and analyses are necessary to make more profound statements.

The format that has been filled in by the yards has not been verified, it is filled in by one person, this could mean that there are errors in the data and inconsistencies in the data per yard.

**Cases**
The root causes have been identified using semi-structured interviews. The data resulting from these interviews have been interpreted to identify the root causes. These have not been verified with the sales or project manager involved. To verify this data a feedback round should be held. This could have been prevented if the data was not collected by interviews but a brainstorm session with the involved managers and identifying the causes together. The interviews on the other hand provide more honest results, as the project managers and sales managers have been interviewed separately and were not reluctant to criticize others.

The calculated profit of the VOR’s have been calculated over the activity as a whole and not only the VOR. The profit made on the activity is therefore not completely linked to the VOR alone, but also on the original tender. The initial profit that was estimated on the activity would provide clarity on this matter.

**PMMM:**
For the implementation plan only one project management maturity model has been taken into consideration. There are more project management maturity models that might be more suitable to the ship repair industry than the model by Kerzner.
Results
The results have not been verified by experts from the theoretical field or practitioners. This limits the validation of the results.

References
Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? Qualitative research (pp. 97-113).
Dictionaries of Approaches Used in Practice
concepts for owners, engineers, architects, and builders: Chris Hendrickson.


Appendix

Ishikawa diagram

Proposed implementation plan
The more mature levels above level 2 require a basis. Essentially the first two levels can be seen as setting that basis, while the upper three levels are a continuous process of improving the project management process. Since the basis in project management in the large non-standard projects is not yet available, this needs to be acquired first. This section will provide insight in the details of the current project management maturity level and a step-by-step plan to increase the project management level towards level 3. The section concludes with recommendations of the improvements that can be made in levels 3-5.

Plan
The implementation plan requires adaptations on two different parts of the organization. On the one hand, on executive level, to provide an organizational culture that is ready to implement changes. On the other hand, the project management itself with its management approach and tools. The executive level changes follow from the maturity model by Kerzner, the project management changes follow from the three research methodologies.

The improvements towards level three are described in a set of steps. These are focused on the executive level to make sure the implementation will be accepted by the organization. On the project management level this includes the aspects that need to be implemented in order reach a common process (create common ground). The project management in this description is seen as the combined effort of sales and project management and covers the whole project management process from tender to close-out.
The total implementation plan is divided into a number of steps (Figure 20). Through these steps the plan will be gradually introduced in the organization and upgrades the project management maturity from level 1/2 to level 3. The steps are explained in more detail in this section.

**Step A**

The first step of the implementation is creating interest in the necessity of project management (Table 15). This interest already exists in the project management driven parts of the company, but the visible support from executive management is low. Inquiries with project managers emphasize the urgency of a (new) management approach from executive management (1). These in their turn can communicate the intentions of improving project management and the strategy towards the whole company, increasing interest in the other layers of management (2) (top-down motivation).

On project management level the first step is to take the management approach guidelines presented in the previous section and create a more elaborate and practical version. This is needed for the common process later on (3)(Figure 21).

**Step B**

After the interest and support has been created and visualized it is time to start the education, which is the most important aspect of level 1 (Table 16)(Kerzner, 2002). It not only increases the

<table>
<thead>
<tr>
<th></th>
<th>Completing level 1</th>
<th>Completing level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support</strong></td>
<td>Executive support exists, but is not visible</td>
<td>-</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>Steps are taken to get insight in the projects’ results</td>
<td>-</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>Non-standard</td>
<td>-</td>
</tr>
<tr>
<td><strong>Interest</strong></td>
<td>Interest in PM exists, mostly in execution</td>
<td>-</td>
</tr>
<tr>
<td><strong>Decision making</strong></td>
<td>Based upon what is in the best interest of the project</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Cost control</strong></td>
<td>N/A</td>
<td>System is at high level, but type varies per location</td>
</tr>
</tbody>
</table>

*Table 15 Creating grounds; step A*
Increasing project management maturity in the ship repair industry

Table 16: Creating grounds; step B

<table>
<thead>
<tr>
<th></th>
<th>Completing level 1</th>
<th>Completing Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>✔</td>
<td>Executive support is visible, further support needed</td>
</tr>
<tr>
<td>Benefits</td>
<td>Steps are taken to get insight in the projects’ results</td>
<td>-</td>
</tr>
<tr>
<td>Education</td>
<td>Non-standard</td>
<td>-</td>
</tr>
<tr>
<td>Interest</td>
<td>✔</td>
<td>Increased interest from project driven areas</td>
</tr>
<tr>
<td>Decision making</td>
<td>Based upon what is in the best interest of the project</td>
<td>N/A</td>
</tr>
<tr>
<td>Cost control</td>
<td>N/A</td>
<td>System is at high level, but type varies per location</td>
</tr>
</tbody>
</table>

Meanwhile the detailed design of the project management approach comes to an end (3)(Figure 22). The evaluation will be improved on the so called soft-skills. An inventory needs to be made of what is necessary to improve evaluation processes and what can be done with the data once the IFS system is implemented (4).

**Step C**

Level one is almost complete and the only aspect missing is visualizing the benefits. A first insight in the projects’ results has been provided in this paper.

Table 17: Creating grounds; step C

<table>
<thead>
<tr>
<th></th>
<th>Completing level 1</th>
<th>Completing Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>✔</td>
<td>Executive support is visible, further support needed</td>
</tr>
<tr>
<td>Benefits</td>
<td>Steps are taken to get insight in the projects’ results</td>
<td>-</td>
</tr>
<tr>
<td>Education</td>
<td>✔</td>
<td>Project management approach is made, SM &amp; PM training</td>
</tr>
<tr>
<td>Interest</td>
<td>✔</td>
<td>Increased interest from project driven areas</td>
</tr>
<tr>
<td>Decision making</td>
<td>✔</td>
<td>N/A</td>
</tr>
<tr>
<td>Cost control</td>
<td>N/A</td>
<td>System is at high level, but type varies per location</td>
</tr>
</tbody>
</table>
Increasing project management maturity in the ship repair industry

(quickscan), for the additional and continuous flow of information the IFS system will be put into use (1) (Table 17).

The hand-over of projects is the next aspect of project management that is improved (Figure 24), since there is a lot of miscommunication and frustration between the project managers and sales managers. Through brainstorming and mixed sessions with both parties new protocols regarding the hand-over are designed. To diminish the frustration a role-playing game will be held to provide insight in the reasons why other parties make certain decisions. This can create understanding and provides a basis for future improvements (2). The last two items that will be part of the education are scope and time management. In these curriculums the focus will lie on creating a sound basis scope to which changes can be identified. This also includes a contract management part, as this aspect is very important in the large non-standard projects but it is underexposed at the moment. Time management is focused on planning techniques that can handle changes and can be applied in a flexible way. Especially the importance of time management and the ways in which one can play with a planning instead of rigidly trying to hold on to the basis planning are important in this aspect.

**Step D**

Since level one is now completed (Table 18), work can commence on further improving on level 2. The ERP system will be running and provides insight in the projects executed in the current approach. This data is used to improve the evaluations and make it an iterative process. (1). The education on project management has reached a level where the implementation of the approach can begin on the projects. The first projects will be managed using the common language and insights provided on the project management aspects. Further education is continued on the theoretical model (2) (Wiskerke, 2015).

The current cost control systems on the yards will be evaluated and steps are taken to decide on an

---

**Table 18 Creating grounds; step D**

<table>
<thead>
<tr>
<th></th>
<th>Completing level 1</th>
<th>Completing Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Support</td>
<td>Executive support is visible, further support needed</td>
</tr>
<tr>
<td>2</td>
<td>Benefits</td>
<td>Insight in the results of the projects is given by ERP system</td>
</tr>
<tr>
<td>2</td>
<td>Education</td>
<td>General understanding of PM reached, first implementations</td>
</tr>
<tr>
<td>2</td>
<td>Interest</td>
<td>Increased interest from project driven areas</td>
</tr>
<tr>
<td>3</td>
<td>Decision making</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>Cost control</td>
<td>System is at high level, but type varies per location</td>
</tr>
</tbody>
</table>
Increasing project management maturity in the ship repair industry

<table>
<thead>
<tr>
<th>Support</th>
<th>Completing level 1</th>
<th>Completing Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓</td>
<td>Executive support is visible, further support needed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefits</th>
<th>✓</th>
<th>Insight in the results of the projects is given by ERP system</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>✓</th>
<th>General understanding of PM reached, first implementations</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Interest</th>
<th>✓</th>
<th>Results from projects increases interest in project management throughout organization</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Decision making</th>
<th>✓</th>
<th>N/A</th>
</tr>
</thead>
</table>

| Cost control               | N/A                | System is at high level, but type varies per location |

**Table 19 Creating grounds; step E**

Aligned cost control system that is used on the projects on all yards. It is important to have a general cost control system to make it easier to compare the projects and exchange people amongst yards (3)(Figure 23).

**Step E**

The ERP system shows the first results (1) of the new project management approach (Table 19). This can be seen by executive management which enlarges their support (2) which can be presented to the whole company to increase the management support throughout the company towards level 2.

The experience with the new project-handover protocols are evaluated (3) and provide a basis for an improved collaboration between sales management and project management (Figure 25). The attention given to this aspect does not only improve the process itself but it also decreases the threshold between the two departments and thereby improving collaboration. The last part of step E is the realization of an aligned cost control system for the large non-standard project across the yards (4).

**Step F**

The last step of the implementation contains the evaluation of the implemented project management

---

**Table 20 Creating grounds; step F**

<table>
<thead>
<tr>
<th>Support</th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Benefits</th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>✓</th>
<th>General understanding of PM reached, first implementations</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Interest</th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Decision making</th>
<th>✓</th>
<th>N/A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Cost control</th>
<th>N/A</th>
<th>System is at high level, but type varies per location</th>
</tr>
</thead>
</table>

---

**Figure 25 Implementing project management; step E**

**Figure 26 Implementing project management; step F**
approach and regular training to keep up with the latest developments in the relevant project management fields (1) (Table 20).

The new cost control system regarding the projects will be implemented in this phase. This is the last step in the implementation of the new project management strategy (Figure 26).

**Final state**
The final result of the implementation plan is illustrated in Figure 27. Both the levels in the maturity model have been finished and from this point the process towards completing level 3 can begin. The project management aspects are partly aligned and partly brought up to an “understanding” level. It is more important to align the cost control system because these systems are often more difficult in understanding. Time and scope management systems are often comparable and easier to understand. When people are sent to other yards it is easier to get to know the planning and scope management systems than a completely different cost control system. In time the scope and time management can be aligned as well. Especially the contract management part of scope management provides added value (as has already been discussed in the previous section). Knowledge on contract management is invaluable since the

<table>
<thead>
<tr>
<th></th>
<th>Completing level 1</th>
<th>Completing Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Interest</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Decision making</strong></td>
<td>✓</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Cost control</strong></td>
<td>N/A</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Figure 27 Final state PMMM**