ONWARD AND UPWARD: VESSEL OPERATIONS AND A NEW GENERATION OF ENTERPRISE SYSTEMS

Korslund, Morten, NHH Norwegian School of Economics, Helleveien 30, NO-5045 Bergen, Norway, morten.korslund@student.nhh.no

Ulla, Hogne, NHH Norwegian School of Economics, Helleveien 30, NO-5045 Bergen, Norway, hogne.ulla@student.nhh.no

Fuglseth, Anna Mette, NHH Norwegian School of Economics, Helleveien 30, NO-5045 Bergen, Norway, anna.mette.fuglseth@nhh.no

Abstract:

This paper explores how a new generation of enterprise systems to support vessel operations may improve organisational effectiveness. The technological improvements of the software are particularly related to the integration of the maintenance and procurement processes, the exchange of real-time data between the main office and the vessels – and the development of a historical account of operations. Our findings show that the short-term effects of the new system on the maintenance and procurement processes are mainly timesaving informational effects because the managers and officers share the same views of data. Transformational effects, such as shorter cycles for handling supplies to the vessels, may reduce downtime. Our findings indicate several long-term effects, as well, such as improved decision making due to better data. These effects may include the development of “best practices” for daily maintenance and fuel consumption. The short-term effects on organisational effectiveness are mainly through reductions in operational costs.

Key words: Enterprise systems, vessel operations, organisational effectiveness

1 INTRODUCTION

Shipping is an important trade for Norway. Norway controls one of the world’s largest merchant fleets. Vessels engaged in foreign trade contributed 13.6 % of the nation’s GNP in 2012 (Eika, Strøm and Cappelen 2013). A rich literature supports shipping owners and managers on shipping investments (e.g. Lorange and Norman 1973). Much research has also been done on minimising costs in connection with scheduling of sailings (e.g. Fagerholt 2004). However, we have not found studies that focus on the potential of enterprise systems to support vessel operations.

Effective vessel operation is important. Shipping managers must handle a global market, which implies both keen competition for freight contracts and pressures on costs. In order to ensure the safety of the crew, the cargo, the vessel and the environment there are comprehensive requirements and recommendations for maintenance and inspection of vessels (e.g. Germanischer Loyd 2014). Furthermore, the vessels represent heavy investments, so it is essential to minimise the downtime.

Operating vessels that sail far from the main office makes special demands on planning and communication. Therefore, a challenge related to enterprise systems to support vessel operations is to develop a database solution that supports real-time replication of essential data between the main offices and the vessels. In addition, the systems must have modules to represent and integrate the special work processes related to vessel operations, such as maintenance and procurement of spare parts and other supplies.

We believe that modern information and communication technology (ICT) provides special opportunities to help shipping managers handle the challenges of running a firm with its assets continuously moving around the world. This paper addresses the following research question:

How may enterprise system software that is designed to support vessel operations increase the effectiveness of shipping companies?
Enterprise systems have been used in shipping companies for many years, particularly for chartering, accounting and human resources purposes. In addition, shipping managers and officers have used special systems to support the maintenance and procurement of their vessels, but these systems were not integrated. Furthermore, communication between the offices and the vessels was infrequent. As a result, managers often did not have real-time data to support their decisions, and officers were unsure of the status of their supplies. In addition, the maintenance of the systems was costly, because updates and corrections of errors had to take place on board each vessel.

Because of these shortcomings, many shipping companies are in the process of replacing their legacy systems with integrated systems. In order to explore the potential of a new generation of enterprise systems to support vessel operations, we report on a study investigating how the implementation of an integrated system (the software package TM Master) may have enabled more effective work processes at a shipping company. We have given the company the fictitious name TeroTankers Ltd. We focus on two processes that are of particular importance to the effective operation of vessels: maintenance and procurement of spare parts.

The rest of the paper is organised as follows: In the next section, we present our literature review, explaining essential concepts and presenting the models we have selected to guide our research. Then we describe our research model, research design and methods for data collection and analysis. In the following section, we present our findings. In section 5, we discuss our findings in light of the models we presented in the literature review, and we evaluate whether the findings lead to improved effectiveness, and if so, how they improve the effectiveness. In the final section, we present preliminary conclusions. We also discuss the limitations of our study and provide recommendations for further research.

2 LITERATURE REVIEW

2.1 Enterprise systems and enterprise system software

Enterprise systems are organisation-spanning computerised systems that integrate work processes and exchange data through a common database. Most enterprise systems have standard interfaces that also allow for the integration of work processes with other organisations. Enterprise systems have a great potential to enhance the effectiveness of business organisations by providing new services to customers, new ways of carrying out work processes and an updated database to support managerial decision making (Turban, Volonino and Wood 2013).

At the beginning of this century, the implementation of enterprise systems was mostly done by adapting a single system software package. The advice to managers was “vanilla implementation”, that is, implementation with a minimum of customisation to the purchased package (Parr and Shanks 2000). Today, the implementation of enterprise systems still mainly consists of adaptations of packaged software, but more than one package may be involved. There has been a development of special software representing “best practices” of certain work processes (e.g. customer relationship management) and certain industries (e.g. oil and gas, banking).

With this development, we find it useful to distinguish between enterprise systems and enterprise system software. We use the term enterprise system to denote the system that has been implemented in a specific organisation. This paper focuses on enterprise system software that has been especially designed to support the maritime industry.

2.2 Implementation of enterprise systems

Our research is based on the assumption that the installation of enterprise system software in itself does not improve effectiveness. Rather, it is the context-specific adaptation of the software together with an organisational change process that may result in increased organisational effectiveness (Mooney, Gurbaxani and Kraemer (1995).

The implementation of an enterprise system involves the representation of the organisation into the selected software. When deciding on this representation, however, the managers must rethink their operations in light of the potential for innovation that is enabled by the new technology. The implementation of an
enterprise system in a specific organisation thus is a systemic innovation (Chesbrough and Teece 1996), that is, the benefits of enterprise system software can only be realised in conjunction with other related organisational changes.

Special enterprise system software is often implemented in addition to other enterprise system packages, such as ERP systems. Both systems have a common database. Therefore, decisions must be made about which data to exchange between the two databases, and a technological solution must be found/developed.

Several models describe enterprise system implementation. Some models focus on the technical aspects of the implementation (e.g. Parr and Shanks 2000; Wysocki 2007). Some models also emphasise the need for business and organisational changes (e.g. Ross and Vitale 2000; Markus and Tanis 2000). For this paper, we have found the model by Markus and Tanis (2000) relevant because their model includes replacement of the software. The model has four phases: Project Chartering, The Project, Shakedown, and Onward and Upward. The Project Chartering phase comprises the decisions that lead up to the funding of the project, or a decision not to proceed with the enterprise system. This phase includes an analysis of the potential for improving business processes. The Project phase comprises the activities to get the system up and running. Key activities in this phase include software configuration and integration, testing, training and rollout. The Shakedown phase comprises the period when the employees are becoming acquainted with the new tools to support their work. This phase ends when “normal operations” have been achieved. During the Onward and Upward phase, the managers may ascertain the possible benefits of the investment in the organisational changes. However, this is also the phase where problems with the current implementation are discovered, which may lead to a new Project Chartering phase planning replacement of the software.

Most literature on the implementation of enterprise systems addresses the first phases of the model. Research on post-implementation successes and failures is still scarce (Iifinedo, Rapp, Iifinedo and Sundberg 2010). A study by Markus, Axline, Petrie and Tanis (2000) reports on adopters’ experiences with their enterprise systems. Nine of the 16 companies studied had reached the Onward and upward phase. Seven of these nine companies reported problems, such as low user skills, difficulties replacing knowledgeable ICT specialists and problems with the conversion to later releases.

2.3 Effects of investments in enterprise systems on performance

Our research is based on the assumption that managers implement enterprise systems in order to increase organisational effectiveness. Effectiveness is an external standard of how well an organisation copes with the often conflicting and competing demands of the stakeholders upon whom the organisation is dependent, such as owners, suppliers and customers (for a detailed discussion, see Pfeffer and Salancik 1978). From a managerial perspective, organisational effectiveness means that CEOs must take care to generate sufficient profit to the owners, while at the same time satisfying customers, suppliers, employees and authorities.

Efficiency is an internal standard of performance. Efficiency is measured by the ratio of resources utilised to output produced (Pfeffer and Salancik 1978). In order to generate profits, managers must utilise resources efficiently. Therefore, organisational effectiveness includes efficiency.

It is usually assumed that effects of investments in enterprise systems are attained through more effective work processes (Mooney, Gurbaxani and Kraemer 1995; Melville, Kraemer and Gurbaxani 2004). Therefore, in order to enhance the understanding of how such investments may result in increased organisational effectiveness, there has been a call for studies emphasising a context-specific evaluation of effects on intermediate work processes (Melville et al. 2004).

Related to this call, several frameworks for studying effects on work processes have been developed. We have used the framework developed by Mooney et al. (1995) to support the analysis of our findings. According to this framework, there are three types of effects in ICT that create value: automational, informational and transformational (Mooney et al. 1995, p. 12). Automational effects derive from technology being substituted for labour. Informational effects emerge from the capacity of ICT to collect, store, process and disseminate data. Transformational effects refer to the ability of ICT to facilitate and support process innovation and transformation.
3 RESEARCH MODEL AND RESEARCH DESIGN

Based on the above discussion, Figure 1 shows the conceptual model of our study:

We assume that managers invest in an enterprise system in order to increase organisational effectiveness. Enterprise systems are enablers of new work processes. The implementation of enterprise systems is supposed to affect performance through more effective work processes. We consider a work process to be “more effective” if the changes in the process contribute to increased organisational effectiveness through automational, informational and transformational effects.

The conceptual model reflects our assumption that the installation of a software package in itself does not contribute to organisational effectiveness. It is the adaptation of the software to represent firm-specific work processes that has the potential for improving organisational effectiveness. Therefore, the effects of an implementation of an enterprise system should be examined in a real setting.

The model also reflects that implementation of an enterprise system may be complemented by organisational changes that are not directly related to the implementation of new software (Melville et al. 2004). For example, managers may decide to reduce the number of employees that are allowed to order goods. Such rules are not dependent upon new software, but enterprise system software may facilitate the enforcement of new rules due to the definition of access rights.

In order to explore the relationships among the concepts, we designed a natural experiment as shown in Figure 2:

We have followed the implementation of the enterprise system for eight months, from May 2014 until December 2014. A pilot installation in the main office and on two vessels was conducted in October 2013. This installation was also the basis for the contextual adaptation of TM Master. In June 2014, the system had been rolled out on all vessels.

In May 2014, we interviewed three managers at the main office in order to elicit the organisational goals and the managers’ perceptions of factors that were critical to the attainment of the goals (Bullen and Rockart 1981). In the interview, we particularly focused on factors that the managers perceived to be critical to the operations of the vessels, that is, we did not focus on the managers’ chartering strategies and tactics. The elicited goals and factors serve as a contextual framework for evaluation of effects of the organisational changes enabled by TM Master in line with the recommendation by Mooney et al. (1995).

In addition, we interviewed experienced managers on the work processes before and after the implementation of TM Master in order to evaluate effects. The mapping of the processes before TM Master
was implemented was partly done in retrospect. Two researchers were present at all interviews, and the interviews were recorded and transcribed.

The data from the interviews about the goals and critical success factors (CSFs) were aggregated in order to identify similarities and differences among the managers. The analysis of each manager’s data was fed back and discussed with the manager. In the discussion, we also clarified whether similar terms used by the managers could be interpreted as synonyms. The result of the feedback meetings was a consolidated representation of the organisational goals and the perceptions of CSFs.

3.1 Experimental setting – the shipping company

TeroTankers Ltd is a family-owned firm with the main office in Norway and two offices abroad. Roughly 40 people are employed at the main office and six at the offices abroad. The shipping company operates around 40 vessels. The fleet has a crew of around 430 people.

TeroTankers specialises in transportation of chemicals in Europe, particularly in the North Sea and the Baltic. This means that the vessels often sail under very difficult weather conditions. Since the cargoes may be harmful both to the environment and to the crew, the ships are subject to special restrictions when they are constructed. As a result, the vessels are among the most expensive in the tanker market. Due to their cargoes, the ships are also subject to special restrictions from the port authorities, which increases the operating costs.

Most of the charters are long-term, varying in duration from five to ten years. The firm also operates in the spot market, particularly in connection with negotiating cargoes for return trips.

At the time of this study, the fleet manager, together with the owners, had decided to invest in an enterprise system for operation of the vessels. The firm had computerised systems to support vessel operations, but they were not integrated. In addition, one of the vendors had informed the fleet manager that the system would not be developed further, and the managers were not satisfied with the functionality of another system.

3.2 The “treatment” – TM Master

We have used the software package TM Master to illustrate the potential of software systems to improve the effectiveness of vessel operations. The vendor, Tero Marine, was founded in 1986. The firm has specialised in software systems for the maritime industry, and TM Master is the main product. The system has been sold to around 150 shipping companies around the world and is currently implemented on about 1,200 vessels. The system is considered to be at the forefront of enterprise system packages to support vessel operations.

The system consists of four main modules: Procurement, Maintenance, Human Resources and Quality & Environment (Tero Marine 2015). The modules exchange data through a common database. The software has a graphical user interface that is similar to the Microsoft Windows interface so that most users can easily learn how to navigate the system.

Since TM Master does not comprise all functions of an enterprise resource planning (ERP) system, the software usually must be integrated with other software packages such as SAP or Oracle. Therefore, the vendor has taken special care to develop interfaces to exchange data with other packages. One of the difficulties of implementing TM Master is to decide which data to store in the TM Master database and which data to store in the ERP system. The vendor recommends that data representing physical objects are stored in the TM Master database so that only financial data are transferred from the TM Master database.

One of TM Master’s competitive advantages is its database solution. Data between the vessel and the office can be replicated at 10-minute intervals. In addition, TM Master has an advanced function to support data cleansing in order to develop a database with compatible data for all vessels (e.g. Inmon, 2005). Thus, the function facilitates queries to the database and comparisons and analyses of the data that are retrieved.

The system provides various views on work processes and data, and it gives access rights according to the users’ role in the organisation. The managers at the main office have access to and can handle data for the
whole fleet. The officers and crew on board have access rights to and can handle work processes and data for their vessel only.

TM Master is installed at the offices and on each vessel. However, the installation on the vessels can be done from the main office. Later updates to the system and corrections or errors can also be done at the main office.

The vendor offers consultancy services and training courses in connection with the implementation. Consultants from the vendor take care of the conversion of data to the TM Master database. They are also responsible for the web-services that exchange data between the TM Master database and the ERP system database. The consultants usually assist a new customer in the implementation of the system at the main office and on a few vessels. Most shipping companies have ICT departments with employees who can then continue the implementation of TM Master in the rest of the fleet.

4 FINDINGS

In this section, we will present our findings from the critical success factor interviews and the mapping of work processes. We have focused on two processes that are essential for vessel operations: maintenance and procurement. The two work processes are interrelated, in part because the maintenance process is dependent on having available spare parts.

4.1 Goals and CSFs

Table 1 shows the goals and policies elicited from the three managers we interviewed by the CSF method: the operations manager, the manager of planned maintenance and the procurement manager. Thus, the reference group represent these three managers. Policies are restrictions on operations that the owners impose on the managers.

The table reflects that we interviewed three managers responsible for the operation of the vessels. These managers were not directly involved in the chartering of the vessels (i.e. the generation of income), but they were all aware that the primary goal of the firm was profitability. The managers did not explicitly distinguish between short-term and long-term profitability goals. Only one manager mentioned the long-term goal of survival of the firm, but several statements from all of the managers showed that their main goal was to attain a satisfactory long-term profitability.

The managers were not willing to share their operational goals with us, but they all focused on the reduction of operational costs. At the time of the interviews, they were particularly concerned with fuel costs because from 1 January 2015 they were no longer allowed to use crude oil as fuel in the North Sea. The operations manager stated:

“The transfer from crude oil to gas oil will represent a considerably increase in our costs.”

Table 1 shows that the managers must satisfy more than the requirements from the authorities regarding the policy “safety and the environment”. They must also satisfy an internal standard, which is defined in relation to the maintenance of the equipment and the safety of the crew, as stated by the maintenance manager:

“We may have more rules than other shipping companies, but the rules have a reason. We want the equipment and the working conditions on board to be safe. When the members of the crew go to bed, they should not worry about their safety.”

<table>
<thead>
<tr>
<th>CSF method - goals</th>
<th>Reference sample: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary goals</strong></td>
<td></td>
</tr>
<tr>
<td>Profitability</td>
<td></td>
</tr>
<tr>
<td>Increase income</td>
<td>3</td>
</tr>
<tr>
<td>Reduce costs</td>
<td>3</td>
</tr>
<tr>
<td>Minimise operational costs</td>
<td>3</td>
</tr>
<tr>
<td>Minimise fuel costs</td>
<td>3</td>
</tr>
<tr>
<td>Procure supplies at the “right” price</td>
<td>2</td>
</tr>
<tr>
<td>Growth</td>
<td></td>
</tr>
<tr>
<td>Increase market share</td>
<td>1</td>
</tr>
<tr>
<td>Survival of the firm</td>
<td>1</td>
</tr>
<tr>
<td><strong>Secondary goals</strong></td>
<td></td>
</tr>
<tr>
<td>Profitability</td>
<td></td>
</tr>
<tr>
<td>Maximise the residual value of the ships</td>
<td>2</td>
</tr>
<tr>
<td>Safety and the environment</td>
<td>3</td>
</tr>
<tr>
<td>Satisfy requirements from authorities</td>
<td>3</td>
</tr>
<tr>
<td>Satisfy internal standard</td>
<td>3</td>
</tr>
</tbody>
</table>
This statement supports the impression from the interviews that the profitability goal is subject to the safety of the crew, the equipment and the environment.

Table 2 is an abbreviated version of the CSFs elicited during the interviews. We have emphasised categories, and we have only included categories that are related to maintenance and procurement at the tactical level. In order to save space, we have not included CSFs at the operational level because they will be described in the processes below.

Table 1 presents the goals from the owners’ perspective, with a focus on profitability. Table 2 shows additional perspectives of organisational effectiveness. In order to generate profit, customers must be satisfied, and the authorities’ requirements must be fulfilled. The operations manager expressed the emphasis on customer satisfaction in the following way:

“The art of handling the market is to be at the top regarding quality – provide good service and deliver according to the customer’s demand. … You must deliver as agreed and be reliable.”

Table 2 reflects the importance of coordinating activities. The maintenance of vessels is dependent on available spare parts. Therefore, procurement must be coordinated with the vessel’s sailings so that supplies are delivered at the “right port at the right time”. Docking of a vessel must be coordinated with the fleet so that chartering contracts are fulfilled when a vessel is out of service. The table also reflects problems in the procurement process. In order to minimise the downtime of the vessels, the managers need to improve logistics and the overview of requisitions and orders. With the change from crude oil to gas oil in the North Sea, the managers must focus more on fuel consumption. These factors are critical to attaining the goal of minimising operational costs.

### 4.2 Processes – Procurement

We interviewed the procurement manager about the procurement process. The manager has the overall responsibility for the procurement of supplies to the vessels, including the evaluation and approval of suppliers. He also participates in negotiation and renegotiation of framework contracts.

In addition to the manager, the procurement department consists of three purchasers. The purchasers take care of supplies to specific vessels. They have the authority to approve purchases up to NOK 10,000. About 300 requisitions/orders are in progress at any time, and they must be followed up closely so that spare parts are available when needed for the maintenance of the vessels. Since we have interviewed the procurement manager, we are referring to him when we describe the process.

The procurement process starts with the preparation of a requisition on board. A requisition is a request for items needed. In order to secure that the right items are ordered, they must be specified in detail. For example, a requisition for a spare part must include the serial number, the name and the model. Since maintenance is often planned for a specific date, the requisition also includes a delivery date.

The procurement manager controls whether the required items should be ordered or not. He ensures that the necessary data are filled in, and whether the request is within the vessel’s budget.

---

**Table 2 Critical success factors**

<table>
<thead>
<tr>
<th>CSF method - factors</th>
<th>Reference sample: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference sample: 3</td>
<td></td>
</tr>
<tr>
<td>Internal factors</td>
<td></td>
</tr>
<tr>
<td>Strategic activities</td>
<td></td>
</tr>
<tr>
<td>Evaluate and adapt the size, age and value of the fleet</td>
<td>2</td>
</tr>
<tr>
<td>Coordinating activities</td>
<td></td>
</tr>
<tr>
<td>Integrated planning</td>
<td></td>
</tr>
<tr>
<td>Plan sailings - have overview of chartering contracts</td>
<td>3</td>
</tr>
<tr>
<td>Plan maintenance according to “TeroTanker standard”</td>
<td>3</td>
</tr>
<tr>
<td>Plan daily maintenance</td>
<td></td>
</tr>
<tr>
<td>Plan dry-docking</td>
<td></td>
</tr>
<tr>
<td>Plan procurement</td>
<td></td>
</tr>
<tr>
<td>Improve logistics</td>
<td></td>
</tr>
<tr>
<td>Improve overview of requisitions and orders</td>
<td>3</td>
</tr>
<tr>
<td>Monitoring of operations</td>
<td></td>
</tr>
<tr>
<td>Monitoring of services - maintain high services to customers</td>
<td>3</td>
</tr>
<tr>
<td>Monitoring of sailings - check sailing position compared to plan</td>
<td>2</td>
</tr>
<tr>
<td>Monitoring of maintenance</td>
<td></td>
</tr>
<tr>
<td>Minimise down time</td>
<td></td>
</tr>
<tr>
<td>Minimise fuel consumption</td>
<td></td>
</tr>
<tr>
<td>Monitoring of procurement - check availability of spare parts</td>
<td>2</td>
</tr>
<tr>
<td>External factors</td>
<td></td>
</tr>
<tr>
<td>Customers - satisfaction (quality, service, deliveries on time)</td>
<td>3</td>
</tr>
<tr>
<td>Suppliers - reliability</td>
<td></td>
</tr>
<tr>
<td>Competitors - changed market shares</td>
<td>3</td>
</tr>
<tr>
<td>Economics - general conditions, exchange rates, oil prices</td>
<td>3</td>
</tr>
<tr>
<td>Authorities - DNV GL, port authorities, IMO</td>
<td>3</td>
</tr>
</tbody>
</table>
When the requisition is approved, a request for quotation (RFQ) is prepared. The delivery must be coordinated with the movements of the vessel. The procurement manager must find suppliers within a suitable geographical area, and he must specify the delivery place according to the vessel’s expected position on the delivery date.

Since year 2000, TeroTankers has used ShipServ in connection with their purchases of supplies and spare parts. ShipServ is an e-marketplace founded in 1999. The system uses the Internet to connect a buyer's purchasing system with their suppliers. By November 2014, ShipServ included over 54,000 suppliers (ShipServ 2014).

The RFQ is distributed to selected suppliers through ShipServ, and quotations are received through the same portal. The procurement manager takes several factors into consideration when evaluating the quotations. Time of delivery is an important factor. The items must satisfy certain standards, such as being ISO-certificated. In addition, the prices are compared. The final step is to place the order and provide feedback to the vessel.

We have investigated the procurement process from a requisition has been sent from a vessel until the item has been ordered with the estimated port of delivery. Thus, we do not include the process from an order is placed and until it physically arrives on the vessel.

4.2.1 The process before the implementation of TM Master

The process before TM Master often started with a need for items drafted on paper by an engineer. The paper was then delivered to the chief engineer or the captain, who held the rights to enter the data into the procurement system. Even though the system had a catalogue of the vessel’s components, data had to be entered manually into the requisition form.

When the requisition had been saved on board, the procurement manager could open it in the system. In order to find a new requisition, however, he had to select each ship and look for new entries. Therefore, it was difficult to get a proper overview of the orders that were in progress at all times.

When the procurement manager controlled the requisitions, he found that necessary data were missing or that data were not consistent in 20 % of the cases. He then had to contact the vessel by phone to get hold of the details. To ensure that the right item was ordered, the officer often sent a photo of the item as an attachment to an email to the procurement manager.

Once the procurement manager had approved the requisition, he changed it to an RFQ and sent it through ShipServ’s database to selected suppliers.

To check whether quotations had been received, the procurement manager had to log on to ShipServ, and he had to remember to look for new quotations. When he had evaluated and accepted an offer, the procurement managed changed the status of the RFQ to an order and sent it to the supplier via the procurement system.

The communication with the vessel on the status of the orders through the system was mainly one-way. The procurement manager could enter a comment on an order, but the officers on board could not reply through the system. For example, if the procurement manager made a comment on a delay in the delivery of a spare part, the officers had to respond to the comment via phone or email. Thus, much of the communication was not explicitly linked to the orders, and the contents of phone calls were not logged.

Due to the errors in the requisitions, bothersome communication to correct errors and lack of system-generated reminders and notifications, the ordering of spare parts might be delayed. Furthermore, misunderstandings occurred because the status of orders was not thoroughly logged.

4.2.2 The process after the implementation of TM Master

With TM Master, the procurement process starts with the opening of a requisition form. The new form requires certain data to be entered before a draft can be saved as a requisition. Furthermore, crew members, such as engineers, are given access rights to develop a requisition. This means that data are entered by the people who need the items.
The database contains a description of all components that is accessible from the Procurement module. The engineer preparing the requisition can select the items from the component list, and the items are copied to the requisition. The engineer only needs to cross-check that the necessary details are in place. Photos or drawings, if any, are attached to the requisitions.

The procurement manager can monitor the preparation of a requisition. Thus, he is aware of needs before requisitions are approved on board, and he can intervene if he foresees problems with the order.

When a requisition is approved, the procurement manager changes the requisition to a RFQ. The change includes the generation of a spreadsheet template to be used by the suppliers when they respond to the RFQ. The RFQ is then sent from TM Master via ShipServ or directly to selected suppliers.

TM Master generates status indicators for the progress of an order. For example, when the procurement manager opens a requisition, the status changes from “approved on ship” to “received and read”. The indicators improve the procurement manager’s overview of the orders in progress. When he logs on to TM Master, he sees an overview of the status of all orders for all vessels for which he is responsible. In addition, the engineers on board can follow the progress of the orders for their vessel at any time.

When quotations are entered into ShipServ, the procurement manager is notified, and he can import the quotations into TM Master. TM Master supports the evaluations of the quotations, among other things by applying different font colours for high and low prices. The support includes the possibility of splitting an order among suppliers to achieve better prices. When the procurement manager has made his decision, he changes the accepted quotations into orders and sends them through TM Master.

If a supplier cannot deliver, it is possible to change the status of an order manually, but such a change requires a comment from the person responsible for the order so that the reason for the change is logged.

The TM Master database saves all purchases so that a historical account is developed. It is possible to add comments to each purchase, for example that the quality of the received item from a supplier was not satisfactory.

4.2.3 Comparison of the procurement process

After the implementation of TM Master, the procurement manager has experienced a decrease in incorrect requisitions. TM Master enforces requisitions with necessary data. The new access rights, the selection of items from the component list and the possibility of attaching illustrations to the requisition have all contributed to the reduction of errors in the requisitions.

The overview and monitoring of orders in progress have been improved. TM Master provides the procurement manager with an overview of all orders for which he is responsible. The engineers can follow the progress of their orders at any time.

TM Master is better integrated with ShipServ than the previous system. RFQs are uploaded into ShipServ from TM Master with a template for quotations. The procurement manager is notified in TM Master when quotations are received, and quotations are imported directly into TM Master for evaluation.

TM Master facilitates the comparison of quotations. The functionality of splitting orders makes it easier for the procurement manager to select more than one supplier for an order from a vessel.

The historical account of all purchases in TM Master improves the possibilities of following the development of prices and evaluating suppliers in terms of quality and delivery times.

4.3 Processes – Maintenance

Superintendents are responsible for the maintenance of one or more vessels. Maintenance takes place in close cooperation with the chief engineer on board. The superintendent we interviewed, who is also fleet analyst, has the responsibility for one vessel.

Maintenance consists of two related processes: maintenance on board and docking. Docking concerns maintenance at a shipyard. For example, vessels that are more than ten years old must be docked twice in five years. In connection with docking, the vessels are also inspected by a classification society such as DNV GL. At TeroTankers, the managers have made a comprehensive effort to describe the maintenance
jobs to be performed on board and when in dock according to the TeroTanker standard. For example, docking of TeroTanker vessels comprises 30 regular jobs.

Before docking, the superintendent prepares a job package together with the chief engineer. The job package is a thorough description of the jobs to be carried out during docking, often illustrated with photographs or drawings. In addition to the regular jobs, the superintendent and the chief engineer may include special jobs based on reports from the crew, or they may decide to move maintenance jobs on board to the docking project. If special spare parts are needed for the docking, these must be ordered in advance.

Based on the job package, the superintendent sends an RFQ to selected shipyards. When the superintendent has received the quotations, he evaluates them according to the following factors: price, experience with the shipyard, the time estimated for the dry-docking, and deviation (i.e. departure from the intended voyage or contract of carriage). For instance, when evaluating the quoted price, the superintendent also has to consider the location of the shipyards. A vessel en route from Norway to Rotterdam, for example, would need three days to reach Latvia, whereas a shipyard in Rotterdam would be just hours from the end destination. In other words, choosing Rotterdam would save six days and a significant amount of fuel.

### 4.3.1 The process before the implementation of TM Master

Before the introduction of TM Master, the maintenance jobs were represented in the system both on board and at the main office, and the system notified the superintendent and the chief engineer about upcoming jobs. The replication of the data between the vessel and the office did not function well, however, and most maintenance-related communication had to be done by email or telephone.

When the superintendent planned a docking project, he opened a folder for the vessel on his personal computer. The folder contained various documents about the operation and the maintenance of the vessel. In the folder, the superintendent generated a Word document titled “Job list”. The document could be a copy of the job list from the previous docking or from the docking of a sister vessel. The document contained a comprehensive description of each of the above-mentioned regular jobs to be carried out during docking. Additional jobs were added by pasting copies of job descriptions into the document.

In the process of preparing the job package, the superintendent and the chief engineer communicated via phone or email. For example, a drawing illustrating wear and tear or damage had to be sent by email. If a spare part was needed, it had to be ordered, and the chief engineer had to communicate with the procurement manager about the delivery time and place. When the job package was complete with the job list and attachments, it was sent to the various shipyards as a PDF file via email.

Quotations from interested shipyards were received as attachments to emails, and the yards used their own templates for the quotations. Before the superintendent could compare and evaluate the quotations, he therefore had to enter the data into a spreadsheet titled “Dry-dock evaluation”. A challenge in comparing the quotations was that the yards designed their offers differently. For example, if the superintendent asked for the price of a job he had specified in three sub-jobs, the yards often used different categorisations. Consequently, it might be unclear what the quoted prices for the sub-jobs included. Such challenges might involve several rounds of clarification.

After a thorough evaluation of the quotations, a shipyard was selected. The superintendent concluded the process by sending an email to the selected shipyard accepting the quotation, as well as an email informing the other shipyards of the result of the evaluation process.

### 4.3.2 The process after the implementation of TM Master

After the implementation of TM Master, the maintenance jobs are described in the module “TM Maintenance” in a similar manner as before, but due to the replication of data between the database on board and at the main office, the superintendent always has a real-time view of the maintenance status. Thus, the need for communication with the chief engineer is reduced.

Furthermore, all data related to the maintenance jobs are now stored in the system. Photos or drawings illustrating incidents on board are stored as attachments to the job. Planning of daily maintenance has been facilitated since the engineers now prepare the requisitions and can follow the progress of their orders in the Procurement module.
The new process for docking starts in the module “TM Docking”. The superintendent selects the vessel and generates the “Job list” using a docking template. The template contains the descriptions of the regular docking jobs according to the TeroTanker standard. In addition, due to the integration of the TM Master modules, the superintendent can select additional jobs in the Maintenance module and move them to the Docking module. Attachments such as photos or drawings are moved together with the job descriptions.

Furthermore, in the Docking module, it is possible to select which items to include in the price, for example, whether certain spare parts will be supplied by TeroTankers or bought from the shipyard.

When the job package is complete, the superintendent selects appropriate shipyards from a list. With a single click, the system generates a ZIP file containing the job list and the attachments. One of these attachments is a spreadsheet template to be used by the yards when generating their quotations. The ZIP file is sent to the shipyards as attachment to an email via TM Master.

The quotations are received by email in TM Master. The superintendent opens the quotations, and if the yard has applied the template, the data are imported into a spreadsheet in the Docking module that supports a comparison of prices.

After a thorough analysis of the quotations, the superintendent selects a yard. The process ends in the same way as before, but emails are generated in and sent through TM Master, and all correspondence is stored in TM Master.

4.3.3 Comparison of the maintenance process

One change after the implementation of TM Master is that documents in personal folders have been replaced by representation of all maintenance data in the common database. This change also implies that the database contains a historic account of the maintenance of all of the TeroTanker vessels.

The communication between the superintendent and the chief engineer has been improved. The superintendent and the chief engineer have the same view of the maintenance status of the vessel because the database in the office is an updated replication of the database on board. Thus, there are few misunderstandings in communications.

The use of templates has reduced the manual processes. Instead of developing the job package from a copy of a Word document, the job package is based on the docking template. Instead of entering data from the shipyards’ quotations into a spreadsheet to compare prices, the superintendent imports the data. Furthermore, TM Master supports the analysis of the quotations.

The integration of the work processes also supports the planning of daily maintenance and docking project. Jobs can be moved from the Maintenance module to the Docking module. Integration with the Procurement module facilitates the planning of maintenance because the engineers can track the deliveries of spare parts.

5 DISCUSSION

In this section, we will discuss the above-mentioned differences between the processes before and after the implementation of TM Master. We will discuss whether the effects of implementing TM Master are automational, informational or transformational (Mooney et al. 1995), and we will evaluate how the effects influence the critical success factors and organisational goals.

Automational effects: The new processes imply few new automational effects. Most automational effects of enterprise systems software such as converting a quotation into an order were present in the former system. However, the templates for receiving quotations for docking from the shipyards and importing the data into the Docking module in TM Master replace the former manual job of entering data for each quotation into a spreadsheet for comparison.

Informational effects: Most of the effects of replacing the legacy systems with TM Master are informational effects. We have found it purposeful to divide the informational effects into two categories. One category concerns effects that save time, but do not necessarily improve the decisions made. The other category concerns effects that may improve the users’ decision-making abilities.
In the procurement process, the procurement manager’s controls of requisitions prevented errors in the former process. The procurement manager’s job has, however, been facilitated: More requisitions are correct, reducing the time he spends on controls. TM Master provides an overview of the status of all orders at TeroTankers. The procurement manager no longer needs to search for new requisitions, and he is reminded of changes in the status of orders that are in progress. Furthermore, TM Master supports the evaluation of the quotations and facilitates the splitting of orders to get better prices.

On board, the captain and the chief engineer have been relieved of entering requisition data into the system through changed access rights. Engineers, who know which spare parts they need, now fill in a requisition form by selecting the items from the component list. If photos are necessary, they can be attached to the requisition.

Due to TM Master’s system of status notifications, both the procurement manager and the engineers can follow the progress of the orders through the system. Thus, the status of the notifications has reduced the need for communication via phone or email and save time.

Relating the above informational effects to the CSFs in Table 2, the implementation of TM Master has contributed to improving the logistics of spare parts, among other things, by improving the overview of requisitions and orders. The support for comparison of quotations and for splitting orders may reduce costs. In the long term, the historical account of purchases may improve the procurement decisions. The procurement manager is responsible for the negotiation and renegotiation of framework contracts. With proper historical accounts of deliveries, he is in a better position to negotiate framework contracts and to select reliable suppliers. Thus, the implementation of TM Master might contribute to reduce operational costs by supporting the procurement of supplies at the “right” price, see Table 1.

The changes in the maintenance process do probably not imply that the vessels are maintained better, but the monitoring of the maintenance is greatly facilitated. The superintendent can ascertain the vessel’s maintenance status in the Maintenance module, and the need to communicate with the chief engineer is reduced. Furthermore, the integration with the Procurement module has improved the planning of daily maintenance because the engineers know when ordered spare parts will be available.

The decisions related to docking project are likely also not improved. However, the process of developing the job package is less time-consuming. The docking template contains the 30 regular docking jobs, and the integration with the Maintenance module facilitates adding extra jobs to the docking project. After the importation of quotation data, the Docking module supports the comparison of the quotations.

Relating the above informational effects to the CSFs in Table 2, the implementation of TM Master has contributed to improve that planning of maintenance, partly by integration with the procurement of spare parts.

When we interviewed the superintendent, he had data for only one docking project in TM Master, but as fleet analyst, he was aware that the database would give him new possibilities to analyse docking projects and to compare shipyards. In the long term, such analyses would place him in a better negotiation position when he compared shipyards and save costs.

Furthermore, the data on the maintenance of all sister vessels would give him new possibilities to compare the operations of the vessels. He might then be able to develop “best practices” for fuel consumption that would contribute to reduce fuel costs (cf Tables 2 and 1).

Transformational effects: The main transformational effect of implementing TM Master is a shorter cycle for handling supplies. Due to the status notifications in TM Master, fewer errors and misunderstandings delay the procurement process from the preparation of the requisition until the order is placed at a supplier. In the need of critical spare parts, shorter cycles may reduce the downtime of the vessels and reduce costs (cf Tables 2 and 1).
6 CONCLUSIONS

We have explored the effects of replacing legacy systems for procurement and maintenance with a special enterprise system package in a shipping company. Our findings show that the main changes in the procurement and maintenance processes are related to the technological differences between the legacy systems and the enterprise system. The enterprise system has a data communication solution that ensures real-time replication of data between the vessels and the main office. It has a common database that integrates the procurement and the maintenance processes. Furthermore, the database provides a historical account of the maintenance of all vessels and all procurements.

Our study indicates that the short-term effects of implementing a second-generation enterprise system package are mainly timesaving informational effects. The system greatly facilitates the managers’ planning and monitoring of the maintenance and procurement processes. The effects are partly related to the real-time replication of data so that the managers and the officers share the same view of the data. However, we also found changes that explicitly contribute to cost reductions. Examples are improved logistics of spare parts and more support for comparing quotations and splitting orders to obtain better prices. In a longer term, our findings indicate informational effects that may improve the managers’ decision-making abilities. The database with a historical account of the maintenance of all vessels and all procurements provide possibilities for learning and improving vessel operations. Examples are analyses of data that might support the development of “best practices” for maintenance and fuel consumption.

In TeroTankers, the implementation of TM Master went as planned. According to the vendor, most projects progress according to plan. This result is different from the study by Markus et al. (2000). One reason is probably that the implementation of a special enterprise software package is less complex than the implementation of an ERP system. We believe, however, that the successful implementation is also related to the collaboration between the managers, the firm’s computer specialists and the consultants from the vendor. The top managers at TeroTankers planned the change project well, and they allocated resources to the project so that the firm’s end-users and computer specialists had the necessary support from the vendor.

Our study has implications for managers. Our findings show that the replacement of legacy systems for vessel operations with a second-generation special enterprise system package may improve organisational effectiveness by reducing operational costs. Our study indicates that such replacement of legacy systems does not need to be a risky project. However, to exploit this potential the shipping managers must enter into a new Project Chartering phase with a thorough evaluation of how the new software can improve the effectiveness of operations in their specific context.

Managers must particularly be aware that the effects of the new software do not come just from the representation of the firm’s work processes in the system. The system must be used as intended. Furthermore, a common database with historical accounts of vessel operations offers opportunities for learning. Through analysis of the data, the managers may not only improve the effectiveness of the maintenance and procurement processes, but they may also increase the effectiveness of the operation of the fleet, such as reduced fuel consumption. Managers must actively exploit the potential of the new software in the decision making process.

Our study has limitations. We have only interviewed the procurement manager and a superintendent about the work processes. Our description of procurement does not include the purchasers’ perceptions of the new system, and we have not interviewed crew members. Furthermore, we have not followed the procurement process after the order has been placed. Thus, our study does not include the monitoring of the deliveries, such as adjusting delivery time and place due to changes in the vessels’ positions.

As described in section 3, we took several initiatives in our research design to improve the validity of our study. In order to achieve descriptive validity (Johnson 1997), two researchers were present during the interview, and all interviews were recorded and transcribed. To increase the interpretative validity (Johnson 1997), the findings reported have been fed back to and validated by the participants. The reported differences between TM Master and the legacy systems have been discussed with an employee at Tero Marine who has a long experience with the former systems at TeroTankers.

A challenge in studies of one firm is to evaluate the degree to which the empirical findings are valid for other organisations. One aspect of this evaluation is whether TeroTankers is an appropriate shipping
company with respect to answering the research question (Gibbert, Ruigrok and Wicki 2008). According to the vendor, TeroTankers is rather representative for their customers, and we believe that our study has produced context-specific insights that might be relevant outside our particular setting. More research is needed to enhance the understanding of how special enterprise system packages to support vessel operations may improve organisational effectiveness. Such research should include failure cases and other types of shipping companies. We should also design longitudinal studies that enable us to measure results over time. As mentioned above, our study does not include possible long-term effects on learning and decision-making from access to better data.

7 REFERENCES