Introducing Performance Measurement in International Shipbuilding
Enabling logistics performance management with performance measurement
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Preface

This thesis report is the end product of my master study at the Delft University of Technology: Systems Engineering, Policy Analysis and Management (SEPAM). At first it seemed that only a small part of the knowledge I gained during my studies would be part of this research. Gradually I discovered that many aspects from the knowledge I gained during my bachelors and masters studies in Delft is reflected in this report. The report is the end result of a research about performance measurement at Damen. All three pillars (engineering, policy analysis and management) of the master study are part of this report.

The end result was only possible thanks to the guidance of the complete graduation committee. Every member has had a specific influence on the end result based on his own expertise. I would like to thank all the members of the committee for this and Martijn Veldhuizen especially for giving me the possibility to perform the research at Damen Shipyards Gorinchem. It learned me a lot about the shipbuilding industry of which I did not know before.

Finally I want to thank my friends and family for supporting me all the time I have worked on this report. Some supported me mentally and others contributed to the substance and lay-out of the report. I would like to thank Kasper Silvius for introducing me at Damen.

I wish everybody fun reading this report.

Christiaan van Dijk

Delft, January 20, 2009
Summary

The research described in this report is about performance measuring and performance management of Logistics at Damen Shipyards Gorinchem. Damen Shipyards Gorinchem is a subsidiary of Damen Group. The Damen Group consists of diverse shipbuilding companies with over thirty production facilities. Within the Damen Group Damen Shipyards Gorinchem is the biggest company with revenue of about one billion euro.

Damen Shipyards Gorinchem consists of seven divisions: Cargo Vessels, Damen Fast Ferries, High Speed Craft, Tug and Workboats, Offshore and Transport, Damen Technical Cooperation and Damen Services. The last division, Damen Services, is not a division that produces ships and is therefore left out of this research. The six divisions that are producing new ships are called product groups. Each product group has its own Director which has quite some autonomy. The organizational model that is applied is a matrix structure where the columns are the product groups and the rows are the functional departments. The product groups are dominant over the functional departments, which is a consequence of the chosen matrix. The product groups together with sales determine what ships will be build in the upcoming years. Where these ships are built is determined by the product groups.

Departments like Project Management, Engineering, Work Preparation, Purchase and Logistics are centrally organized at Gorinchem. Building of the boats is mostly done at yards in foreign countries. As a consequence of all the preparatory activities in Gorinchem and the roots of the company most parts are bought in the Netherlands and transported to the yards. The distinctive feature of Damen when compared with other shipbuilding companies is that Damen focuses on outfitting. This research is therefore mostly suited for the outfitting process. The figure below shows the work sequences that have to be followed.

Logistics of Damen starts at Engineering. Engineering makes drawings which have parts lists attached to it. When Engineering finishes these drawings they are handed over to Work Preparation who then completes the parts lists. As soon as Work
Preparation determined in which shipment the parts have to be sent. Purchase starts ordering the parts. Parts can either go directly from a supplier to another supplier to compose it in a module; parts can go from the supplier straight to the yard; or parts can go from the supplier to the Warehouse in Gorinchem. In Gorinchem parts are checked, whether it are the right parts in the right condition. Then in principle cross docking takes place. Parts are batched on project and loaded on a truck or in a container to be transported to the yard. It is essential that the yard receives all the parts in time so the building process will not stagnate. In the years 2004 till 2008 a massive increase in orders and production has shown. The company had to scale up and hire many new employees while the old employees were making a lot of overtime. Managers were faced with an increase in the span of control as they got more and more employees underneath them. The growth of the company and the growth in span of control triggers formalization. There is resistance to formalization by the employees that are faced with it and are faced with less control over their own work. Within Damen formalization is not an easy objective.

The consequence of the growth in employees at Gorinchem and the increase of yards at foreign locations was that the Logistics Manager starting to look for new ways to manage his departments. The research question of this report is thus: "what improvements can Damen make to get in control of logistics and to upgrade logistical performance?"

Logistics is in fact spread out over different departments, hence Engineering and Work Preparation are involved in material identification, Purchase is responsible for ordering the parts and assuring that the parts are delivered on time in the right conditions. Warehouse together with Transport Coordination and Expedition are responsible for the parts leaving the Netherlands on time to be delivered on time at the yards. The spread of responsibilities combined with international growth and the matrix organization leads to complexity at Damen.

The solution presented in this report is a performance measurement system with metrics on the crucial interfaces and processes which have to guarantee a smooth logistical process. The figure below shows the positioning of these metrics in the process. Important inputs to the performance measurement system are the support of departments and quality of data. An important aspect of the data is the planning. Only when the planning is made consistently and updated regularly reference points for measuring delivery reliability are available.

An important part of the performance measurement system is the reliability of the supplier and the quality of the deliveries. Purchase handles all the contacts with suppliers. With some of these suppliers are bilateral contracts while for others only the general purchase conditions apply. Purchase has more possibilities and agreements with suppliers through the different standard documents than is realized. There are different requirements in the different documents that should be standardized so all the suppliers are faced with the same requirements and all the suppliers will deliver the parts packed and labeled the same. For the warehouse of Damen this is a significant impact. Because all parts are ordered for a specific project, the Warehouse has to handle it per project as well.
Each red letter in the figure represents the positioning of one or more metrics:
A  Drawing delivery reliability  
B  Supplier delivery reliability, supplier quality  
C  Responsiveness lashers, responsiveness trucks  
D  Inventory control (DTC and non-DTC), productivity  
E  Transport time, air freight  
F  Reliability at yard, incompleteness, incorrectness

To the performance measures presented above hierarchy can be added. First of all there are five need-to-haves that are required to make the first success of performance measurement:
1. deliver reliability at the yard;
2. incompleteness,
3. incorrectness,
4. supplier delivery reliability;
5. and supplier quality.

Apart from need-to-haves are three categories of nice-to-haves. The most important category of nice-to-haves contains one performance measure:
1. drawing delivery reliability.

Drawing delivery reliability is at the moment hard to measure because data is overwritten when alternations to drawings are made. The importance of it springs from the fact that Work Preparation and Purchase have to wait for Engineering to select and order the parts that are needed to build the ship.

The second category of nice-to-haves contains five performance measures:
1. responsiveness lashers;
2. responsiveness trucks;
3. inventory control DTC;
These performance measures are of a lower level than the need-to-haves and the most important nice-to-haves. The strength of these five performance measures is in the fact that they are dedicated to small parts of the process and will be useful when the demand changes. Possibly improvements can be made in these processes, although without measurements it is not sure how much improvement can be made.

The least important performance measures presented in this report are:
- productivity;
- and air freight.

Productivity is most important when the workload in the warehouse changes and new employees have to be hired or when there exists excess capacity. Air freight is used to be flexible with Logistics. Tight measuring of this performance measure could result in a decision to decrease air freights causing other costs in Logistics to go up or even that production is delayed as a result. It can however be useful when the number of order lines processed goes down and Damen is better able to handle the demand within the standard office hours. At such a moment air freight should decline, although never vanish.

When the performance is measured it should also be managed. This can be done with the use of the framework presented below:

It is important to fill in all the blue ovals. Only when the system is consequently used, performance management will be possible. For every metric it needs to be clear: what will needs to be measured, who measures, the frequency of measurement, the frequency of review of the performance and who acts on the data. Management is responsible for determining the goals and norms. The main goal of the system is to improve the performance of Logistics. Therefore for all the metrics improvement can be added if the performance is not optimal, even when there is no norm.

Three design principles are needed when performance measurement is used to manage the performance of Logistics at Damen to prevent perverse effects:
- interaction;
- variety;
• and dynamics.

Interaction is safeguarded by involving different stakeholders in designing the performance measurement presented in this report. Interaction is used to create trust in the performance measurement system. Variety is needed to prevent monopolization of the meaning making rights. When only one person is responsible for meaning making, many actual reasons contributing to a certain performance will be left out. Complexity results in the fact that a single employee does not know all the details. When the performance of a particular measure is lacking, several causes might form the fundament. Only when different stakeholders are involved in explaining the performance these causes will be found. Dynamics is needed to update the performance measurement system when the desired performance is reached or when the environment changes and changes should be made to the performance measurement system. Dynamics keeps the performance measurement lively within the organization.

With the performance measurement system presented in this report it should be possible to improve the performance of Logistics of Damen. During the research not much data was available to assess the performance. The little data that was used showed a lacking performance. When this performance was shown to the responsible persons they were surprised by it. Although they clearly had an idea that performance was not optimal, it proved to be worse than they thought. Because the solution has several performance measures it is possible to improve the process at different places in the supply chain. Bottlenecks can be identified as soon as data comes available. If data will come available depends heavily on the support of the different departments and the strength of the Logistics Manager to convince the different stakeholders of the need of the performance measurement system.
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1 Introduction

1.1 Damen Shipyards Gorinchem

Damen Shipyards has shown a fast increase in the recent years. The company is developing more and more to an international player in the field of shipbuilding. Yards of the Damen Group are located all over the world: from Cuba, China, Singapore, Poland, Romania, Belgium, Sweden till the United Kingdom and the Netherlands. Apart from the (partly) owned yards; Damen works with yards in the Middle East, the horn of Africa and South America amongst others. The roots of the company are in the Netherlands, to be more precisely in Gorinchem where today the headquarters is still located. The company started with just one yard and was established by the father and uncle of the current president. The company remained to be a family business.

Damen gained its competitive edge in 1969 when it introduced modular shipbuilding (Damen, 2008a). Modular shipbuilding appeared to be a large breakthrough and Damen grew while other shipyards in the Netherlands shrunk.

![Figure 1-1 Overview of the yards where Damen projects are built. Source: http://www.damen.nl/Companies/index.aspx.aspx?mId=8562](viewed on October 24, 2008).

Because the Damen Group consists of so many yards around the world, work processes have to be adapted according to the new situation. Much of engineering, work preparation, purchase and logistics are done in Gorinchem while the physical construction of the ships is done at the yards. Especially logistics is gaining in importance with more and more shipbuilding at foreign locations.

This research aims at the Logistics of one of the subsidiaries of the Damen Group: Damen Shipyards Gorinchem. Damen Shipyards Gorinchem is the biggest company within the Damen group and consists of the work groups: Tug and Workboats (T&W), Cargo Vessels (CV), Offshore and Transport (O&T), Damen Fast Ferries (DFF), High Speed Craft (HSC), and Damen Technical Cooperation (DTC). In the rest of this report whenever is written Damen, this means Damen Shipyards Gorinchem.

1.2 Logistics

To be clear for all the readers of this report some definitions of logistics are given. During the research it became clear that most respondents think about distribution
when is talked about logistics while material and resource definition is part of logistics as well.

Coyle et al. (2003) recognize four subdivisions of logistics all having their own definitions. These four are:

1. Business logistics  
2. Military logistics  
3. Event logistics  
4. Service Logistics

Military logistics is tailor made for operations undertaken by the army. Event logistics aims at single events, the logistical activities to prepare the event and the activities needed to perform when the event has finished. Service logistics is only applied in service industries. Therefore the only interesting subdivision of logistics considering the research at Damen is business logistics:

“that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from point of origin to point of use or consumption in order to meet customer requirements” (Coyle et al., 2003).

Also a general definition of logistics is included in the work of Coyle et al. (2003):

“Logistics is the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimizing the goods- or service-producing network to fulfill customer requests; and utilizing the network to fulfill customer requests in a timely way.”

1.3 Process description

Starting point of logistics is the moment a project is noted on the high probability list. From this moment on Purchase has to start working to assure on time delivery of long lead items. At the same time the product group together with Sales should try to come to a sale of a project with specifications of the ship. Next to ships that are dedicated built for a customer there are also ships that are not yet sold to a customer, however they are already detailed according to a standard design. As soon as specifications are known for a new project Engineering is able to start its work. Administratively the logistical procedures can only start after Engineering has released drawings. The reason for this is that the drawings that contain detail to the ship are connected to parts lists, indicating a couple of the parts needed for that specific section of the ship. If Engineering has not finished because alterations to the standard have to be made, it is not yet possible to order the parts. The logical connection between Engineering and Work Preparation is incorporated in the ERP package.
Every standard ship type has its own specification detail. Drawing packages of standard ships are connected with a standard parts list. This parts list does not contain all the parts needed for a standard ship so the list should be extended by Work Preparation depending on the production yard. The reason that Engineering does not deliver drawings with all parts connected to it is that on the one hand specifications change too much and on the other hand employees of Engineering do not have the same affinity and knowledge of the components as the employees of Work Preparation have. Other activities done by Work Preparation are determining how the parts will be transported to the yard. Work Preparation determines if the parts go direct from supplier to the yard or if the parts are consolidated for shipment in Gorinchem. The idea is that the larger items are directly send to the yard while the smaller parts are send to Gorinchem where they are consolidated to lower transport costs (Veldhuizen, 2006). Work Preparation is also responsible for processing rush orders. Sometimes a part is missing at the yard because it never was ordered or it was ordered but never arrived. Other times a part is damaged during transport or damaged during installation. In all these cases the parts have to be replaced with new parts, most of the times the parts are needed as soon as possible or at least within a few weeks. Waiting for a regular shipment to go to the yard is not an option because regular transport will require more time. These parts have to be sent with DHL or are sent with air transport. It is one of the tasks of Work Preparation to assure that these parts will be at the yard as soon as possible.

The regular moments of delivery to the yard is fine-tuned by Work Preparation based on the sketch on outline determined between the yard and Project Management. The yard signs an exhibit with the product group. This exhibit contains when the components are needed on the yard. The milestones are first determined and Work Preparation has to make batches of the parts that are needed at the yard. The plan made by Work Preparation has then to be approved by the yard, although this is not done all the time.
Once Work Preparation has identified which parts are exactly needed, based on the drawings, the standard parts lists and the extra parts that are needed and added by Work Preparation, Purchase can start to order the parts with a preferred delivery date attached to the order.

As soon as the order is placed, a grey area originates. For larger components and sets a notification is made a week in advance of delivery. However, many parts are just sent to the required delivery address without prior notification. The consequence of this system is that it is often not known that parts will be late, until after they were supposed to be delivered. When the parts are not registered as received in the ERP package, Purchase will get a notification of late delivery, generated by the ERP package. However, as the Purchase Director points out, there are so many notifications of late deliveries, that Purchase does not take contingency measures in many cases.

The orders that are not sent directly to the yard are received at the Warehouse of Damen. As soon as the parts are identified with the order number a receiving paper is printed and mounted on it. The parts are then put on inspection. The inspection is to assure that the order is complete and contains the right products. If several parts for different orders are combined in one package, the package is split according to the different orders. As soon as the check is completed the parts are stored and a location is scanned and saved in the ERP package. Storage should take at its most two to four weeks depending on the product group. The parts are then picked according to a picking list and packed to make the parts ready for shipment. When all the parts that will be included in one shipment to a yard are picked and packed, external companies will start lashing the shipment in containers for yards overseas, or a truck is loaded when the yard is located in Europe. At the same time the transport documents are made by Work Preparation, Transport Coordination (Transco) and Expedition. What parts of the transport documents are made by Transco and what parts are made by Work Preparation depends on the product group. The different product groups do not have complete uniform working processes.

It is important to realize that when a part is not stored in the location as it should be, the part will go missing and is hard to identify. When the part that is picked is in the area next to the area it should be, it may very well be that this part will end up in Brazil instead of Indonesia or Vietnam. Other grey areas concern the containers. When a container is completely loaded, the container cannot be put on transport yet because first all the shipping papers should be completed. However, sometimes there is not enough space to leave the container standing at Gorinchem so the container is temporarily stored in another place, for instance at the site of Boerman (trucking company). This location is noted in an Excel document. However, earlier the document was not discussed on a regular basis which resulted in containers that were ready for transport to be stored for several weeks. The result of this is that the parts in the containers will be late at the yard and that the yard will request urgent deliveries.1 The amount of time it will take to unload the parts and put the parts that are urgently needed on air transport is gigantic. Although only a small portion of air freight is taken out of containers, too many resources are spilled with these disruptions.

Transport to European countries is relatively easy because of the free movement of goods in the European Community. A truck leaves Gorinchem and will drive within five days to for instance Romania. Sea transport of containers deals with more

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1 Employee of Work Preparation, HSC
problems. First the containers have to be transported from Gorinchem to a container terminal in the Port of Rotterdam. Then they will be transshipped to the container vessel which will deliver the container to a terminal in the country of destination. Here often problems occur. Every country or sometimes even every province will have its own customs regulations. If the transport documents are not according to the specific requirements or if the transport documents differ from the substance of the container, the container will be seized by customs. All the parts inside the container will then be late at the yard. This can easily add up to several weeks of delay.

Figure 1-3 Logistical process. Source: author

The total process as described above can be summarized into Figure 1-3. It can be seen in this diagram that the strategic buying of long lead items is done before project management has started up. The other activities fall under the responsibilities of the project manager as can be seen by the dashed lines. This does however not necessarily mean that the project manager is in control of all these activities. In practice project management is mainly focused on engineering and purchase and less on logistics.

The green circle is used to show that the departments Transport Coordination and Expedition are involved in arranging the transport and preparing all the paperwork needed for transport and for customs. In the future Work Preparation should also be included at the green circle as they will be responsible for the packing lists. Not included in the figure is the fact that transport is performed by external companies, specialized in road transport, air transport and freight transport across seas. Also the filling of the containers is done by employees of an external company (Unilash) because they are specialized in locking all the goods in a container so that even with rough weather the goods will stay in a neatly way in the containers.

Although the assembly activities at the yard also include logistical challenges, this falls outside the scope of this research. Another part of logistics that is not included in the scope of this research is the return line of goods and containers. In practice hardly anything is returned. Parts that are not needed are often kept at the yard for other projects. The containers Damen uses are mostly bought second hand and painted blue. It is too expensive to ship the empty containers back so often they are

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2 Attachment 2 of Memo 061 MV
3 Memo 061MV
left at the yard where they are used for storage or used as offices. Otherwise they will be sold locally.

1.4 Problem symptoms

1.4.1 Automotive versus shipyards

This paragraph gives a brief description of the problems at Damen regarding the logistics. Shipbuilding is very different from most other industries. The characteristics of the shipbuilding industry are summarized in Table 1-1. The volumes in the product groups of Damen are not high enough to consider it mass production. A ship is not build on a conveyor belt like for instance a car. Another important difference between building a ship and building a car is that a car has a fixed customer order decoupling point. The shape of a car is determined; a customer can only choose things like color, materials mounted on the seats, rims, stereo, and engine. These possibilities are all fixed. A customer cannot choose every color as he orders a car at Toyota, he can only choose between for instance ten selected paintings.

A ship is very different from a car. If a customer wants a lower cabin, or a crane mounted on the back, or a special fire fighting system he can order it in any color he likes. It is even possible to order a ship that is one meter shorter than standard, however such a relative small difference is in practice not made because of the extra costs. The options are not set for a ship as is done with cars. Every customer will ask for specifics which can be a small adaptation to a standard, or a very large one.

Table 1-1 Characteristics of shipbuilding industry. Source: Author

<table>
<thead>
<tr>
<th>Characteristics shipbuilding industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fixed order decoupling point</td>
</tr>
<tr>
<td>Low volumes per ship type, no mass production</td>
</tr>
<tr>
<td>No use of conveyor belts or robotic arms</td>
</tr>
<tr>
<td>Every requirement of a customer can be facilitated</td>
</tr>
<tr>
<td>Shipbuilding is labor-intensive</td>
</tr>
<tr>
<td>Relatively low part of employees is highly educated</td>
</tr>
<tr>
<td>Much learning on the job</td>
</tr>
<tr>
<td>Relatively late development of IT systems</td>
</tr>
<tr>
<td>Many small (often specialized) suppliers</td>
</tr>
<tr>
<td>Globalization</td>
</tr>
</tbody>
</table>

1.4.2 International growth

Damen has grown very fast in the recent years. In 2007 189 ships were sold while there were only 82 ships sold in 2004 (Silvius, 2008). To facilitate this growth more ships are built overseas. There is more capacity available in foreign countries than in the Netherlands and labor is far cheaper in Asia than it is in Europe. The Eastern European countries that were used a lot for building new ships for Damen are traded in for Asian countries. With Ukraine, Poland and Romania joining the European Community the labor costs went up. It is hard to keep margins up by working more efficiently when labor costs go up in such a short time.

Building ships in Asia gives problems for the regular work processes. China only has three hours overlap in work times with Gorinchem in which calls can be made and emails can be answered.

When more ships are sold, more building capacity is required. Often there are no large yards available that can start building ships for Damen tomorrow. Small yards are bought in for instance China and transformed into large yards within a few years.
The employees have to grow with these developments, otherwise productivity will stagnate.

1.4.3 Goals of planning

In the beginning the only planning that was done was designing the yard plan. Later many departments introduced their own plans, which did not give enough insights. Major problems were that planning methods were too complex and too time consuming. With the increase in projects change was needed (Rebel, 2005). The idea behind central planning was that insights in milestones and detail plans of all projects would make the processes more transparent and better controllable. Increase in transparency of a project would decrease company risks, increase efficiency and would lower cost levels.

In the beginning of 2008 the use of the selected planning software package, Trimergo, had almost bled to death. Many project managers are not using the planning software. If plans are created in Trimergo, they are not updated when something changes. Another problem with the plans is that there is not any control if the deadlines are made or not. However, these deadlines are very important because the processes performed by the different departments are linear connected as described in paragraph 1.3 and visualized in Figure 1-2. At the moment a lot of complaints are heard that are connected to the plan. One of these complains is that drawings are not released in time. Another problem is that parts are not delivered by the supplier according to plan.

It can be concluded based on these observations that the acquisition of Trimergo has not resulted in the goals aimed for by Frank Rebel. The transparency has not increased and the same goes for the efficiency. This does not mean the goals were not correct, but that the usage of Trimergo is not as it should be. Progress of milestones and processes should be measured to make planning software a tool that boosts efficiency. Only with correct usage and up to date information the planning software can do justice.

1.4.4 Usage of planning

One of the overall problems can be found in communication. The organization of Damen can be acknowledged for its little islands. Every product group operates in its own way. Functional departments do not cooperate much either. As described by Silvius (2008) there are borders between the departments, and these interfaces are not managed. Work packages and responsibilities are thrown over the fence without structural and in-depth communication. When there would be a lot of information available and questions were not raised, it would not be a problem. However because of the fluctuating quality of the delivered work and the available time in combination with the needed time there do occur problems. These problems result in tensions between employees and departments. At the moment the root of these tensions cannot be identified. It is not clear where problems that occur down the supply chain originate. To tackle the problem at the root, it is important to know where the root is located.

An improvement course has been started up. Planning used to be hardly done at Damen. The little planning efforts that were made were more targeted at satisfying the customer than at managing and streamlining the projects\(^4\). Today two people at Damen Gorinchem are responsible for making the plans, although the content of the plans falls under the responsibility of the project manager. The input to the plans must come from the different project managers. These project managers are also

\(^4\) Interview with Huib Slings, Production Manager Cargo Vessels, on August 29, 2008
responsible that the plans are updated; the two employees can enter new dates for them or the update can be entered by the employees on Work Preparation. The goal of the central planning employees is to create more control on the logistics per project. Planning should be useful to steer departments in logistics. However, this is only the theory. In practice the plans that are created do not contain a high level of detail. Moreover they are not updated when the planning of a project changes. Because the changes made by project management are not altered in the official plans, the possibility to steer logistical departments is compromised. This could be intercepted by communication between project management and for instance Work Preparation and Warehouse, however in practice this is not done either. The result of this is that the Warehouse has difficulties to set priorities on which projects they should pick first. The Warehouse is crossed by parts destined for approximately 250 new built ships. They simply cannot determine where the focus should be. On top of that, it is not the responsibility of the Warehouse to determine priorities. This responsibility lies at project management. Communication is the key to the quality and timeliness of logistics.

For steering of the logistical departments and for determining disturbances caused at other processes needed for adequate logistical performance it should be better when the bottlenecks would be identifiable based on numbers and figures. Not only would the Manager Logistics be better able to steer its responsible departments, the figures could be used by the project managers as well to assure the successes of their projects.

### 1.4.5 Administrative

Administratively there are still challenges at Damen. Work Preparation has to complete parts lists with all the parts needed to build a ship. There are however differences in the level of detail they have to add. First of all these differences are created by whether a ship is a new design or built more often. Then it also depends on the experience of the yard if parts are sourced locally or if they are bought in the Netherlands and are processed by Work Preparation and Purchase of Damen. Next there are differences caused by the product groups on the one hand, and on the other hand differences are caused by the purchasers and project managers. For some projects it is enough to put a fire fighting system on the parts list, while others want to have a distinction between the hose and the cylinders filled with powder or foam.

When the order is placed the Warehouse has to process the order when the parts of the system are delivered. The system can be delivered at once or in different phases. It is important at such a time that it is clear which parts are part of which order, would it be ordered in detail and not as one order.

Parts that are received will have to be checked and later stored. It is important that the parts are checked with the right information available so the employee knows what it is and if it complies with the order. When the parts are stored they should get a location in the ERP package and the parts should have a paper mounted on it to identify it. It is also important that the parts are actually stored at the location according to the ERP system and not in a different part of the warehouse.

When the parts are collected and physically ready to be shipped transport documents have to be made. If these transport papers are not correctly made, do not contain the required information or are not conforming the parts that are in the shipment Customs will seize the parts with a large delay as a consequence.
1.4.6 Suppliers
But not only Damen is confronted with time pressures. Suppliers of Damen are also confronted with time pressures. The suppliers of Damen which are often also suppliers to other shipyards and all have a very large order portfolio to manage. They are confronted with shortages of personnel, just as Damen is. Raw materials are going up in price because of higher demands of upcoming economies. The rising of prices of metals causes speculations which in turn will lead to longer lead times. For instance the rise of the price of copper caused the supply of screws to be delayed while the demand for screws went up. Another example of problems with supplies is the supply of bearings. There was a large shortage of bearings while it is almost a commodity as it is used in so many industries.

At Damen it is known that suppliers have increasing lead times. Sometimes it is even part of a contractual agreement between Damen and the supplier (e.g. Reintjes). However, it is not known which suppliers are often late with deliveries and which suppliers are more on time. Also there are no track records of the amount of time a delivery is generally late. Damen has many demands on its suppliers as will be discussed in chapter three. At the moment it is not clear whether a supplier delivers late because of failing Work Preparation of Damen, failing of other departments of Damen or if the supplier fails.

1.4.7 Other problems
In the summer of 2008 the warehouse was completely full and more and more parts had to be stored outside. Parts were leaving the warehouse too late, parts went missing, parts were delivered too late at the warehouse, the wrong parts were delivered to the yards, documentation was not confirm the parts in the containers, and a heavy increase of air freights was the consequence. Parts that went missing were a consequence of the full warehouse. These parts had to be stored somewhere; sometimes they were directly put in a container, at other moments they were stored outside. Parts that were stored outside did not get a location in the ERP package. Employees had to keep lists of where these parts were stored, or otherwise they had to walk around to look for these items. Searching for parts consumes a lot of time. Mistakes are easily made, especially when the picking employees do not have enough product knowledge they will easily pick the wrong product if the product is not correctly marked.

Mistakes were not only made caused by the lack of location numbers. The increase in projects made it necessary to hire more employees in the warehouse. These employees did not have a background in shipbuilding. If the processes were all waterproof, this should not lead to any problems, however at Damen it is important that most of the employees in the warehouse have some product knowledge. The moment that the employees were hired was quite late. When the throughput went up, more employees were hired causing a shift in experiences versus non-experienced employees. Because of the high work pressure, many employees did overtime in the evenings and weekends. There was not much time to break new persons in. Less experienced employees make more mistakes because they are not acquainted with all the details of the work processes and they are not acquainted with all the products they have to handle.

Mistakes made in the warehouse and made in predecessor processes (e.g. Engineering, Work Preparation, Purchase), in which also many new employees are deployed, have to be corrected as soon as they are discovered. It is the question whether all discovered mistakes are actually corrected at the spot, or whether people let them slip through because they do not want to spend time on it. However, the yard has to receive the right products in the end and within a certain timeframe;
otherwise the boat cannot be completed. Often Work Preparation employees try to correct mistakes and missing items. They go looking for parts in the warehouse to put them on air transport or to fill a suitcase that is taken to the yard by for instance a project manager. There is however a big risk that these parts are not registered as picked. The next time the regular order pickers pick the parts for a project, they will not be able to find these parts because they are already gone, but they do not know it. In this way a lot of time and resources are spilt.

### 1.4.8 Consequences

To summarize there are many difficulties the logistical department is faced with. First of all customer demands are not preset as in the automotive industry. Second the fast growth has had its reflections on building capacity which is now located more and more in Asia. These yards have to be developed and as soon as they do, the responsibilities of departments like Work Preparation and Purchase change. When a yard is new, Damen will have to do a lot. When a yard is more developed more is done locally.

Planning is not yet used at its full extend. The goals set by management will only be achieved if plans are regular updated and performance is measured. Then it will be possible to use planning as a means to steer logistics.

Furthermore difficulties are at the grey areas that are part of the administrative processes and administrative systems. This causes parts to go missing. Also it leads to abuse through for instance releasing parts in the past. This does not help the organization. One of the quality objectives of Damen Shipyards Gorinchem states that “company interest prevails over departmental interest. Another objective states that “facts are the basis for action”. It is important to recognize this and improve the total processes of Damen. Insights created in the performance of suppliers will lead to an improved supply chain.

This improved supply chain will have its effect on work climate in the warehouse and at other departments. When the administrative systems are more waterproof and when grey areas become more transparent, fewer mistakes will be made. Work pressure will stagnate and there will be more time to learn the processes to new employees. Still, it is important that improvements are made first, based on actual numbers, not on presumptions and feelings.

### 1.5 Research goal

The goal of the Logistics Manager is to steer the logistical departments on performance, including development of the processes, and to determine what problems influencing Logistics are not caused by the departments under the direct responsibility of the Logistics Manager. It is his goal to point the other departments at their responsibilities, supported by facts and numbers, instead of getting the blame for problems that have grown from other sources and to cooperate in constructive solutions. The goal of this research is to facilitate the Logistics Manager in this specific need. Furthermore the goal of this research is to determine what the boundary conditions are for determining the logistical performance. These boundary conditions spring from data availability, but also from the organizational structure of Damen and the development of the organization. Much will depend on other departments. These departments have to be included in the boundary conditions.

The solution to this problem should be able to deal with future business developments and should be usable on an operational level as well as on a tactical level. The minimum contribution of this research will be that the topic gets more
attention within Damen and that it will be part of the discussions about the
development of the company.

Management of Damen does not have the insights in the performance of logistics as they want to have. There exists a feeling that logistical processes could be improved, although the performance cannot be measured at the moment. At least management has a need to increase steering on performance on an operational level with in mind business development in the upcoming years. It is not known yet which parts of the business will change, so a solution should be able to deal with uncertainty.

1.6 Research questions
With the above descriptions and problem definition it is possible to define the research questions. There is one main question which is written in italics and this main question is supported by six sub questions.

What improvements can Damen make to get in control of logistics and to upgrade logistical performance?
1. What agreements are made between Damen and its supply chain partners (i.e. suppliers of goods and suppliers of services) considering logistics?
2. What performance measurement on logistics is currently executed at Damen?
3. What requirements on a logistical measurement system can be derived from literature and from within Damen?
4. What is the performance of logistics at Damen based on the requirements as set by question three?
5. How can performance measurement be used to stimulate continuous improvement at all departments influencing the logistics of Damen Shipyards Gorinchem?

1.7 Research approach
To answer the research questions a specific approach is followed. The answers to the five sub questions will result in an answer to the main research question as can be seen in Figure 1-4.
To answer the first question, the Director Purchasing is interviewed and several documents of Damen are used. These documents are mostly internal documents, general documents, or contracts with suppliers.

To answer the second question interviews are held with the Director Purchasing and the Logistics Manager. On top of that a presentation is attended given by planning employees and attended by a diverse group of employees of Damen. The company documents that are studied consist of the graphs and files that are used to measure and present the performance.

The third question will be answered by using the literature from chapter two regarding requirements on performance measurement. Employees that are interviewed are from Expedition, Transport Coordination, Work Preparation and Warehouse plus the Logistics Manager. These same interviews also contributed to create a complete picture of the work processes which are discussed in chapter one and the first half of chapter two.

The fourth research question will be answered by extracting data from the ERP package of Damen and measurements performed in the warehouse of Damen. The calculations on the data extracted from the ERP package are processed by the author of this report, while the data from the measurements...
in the warehouse are taken from an employee. However, the author of this report has joined several meetings with the Logistics Manager, Head of Warehouse, Warehouse employees, and two supporting employees who looked at the processes in the warehouse (Maria Fernanda Parra Jimenez and Jeroen Ebbelaar) to discuss how the performance should be measured and to discuss the preliminary results of the measurements.

- The fifth research question will be answered by literature on performance management and experiences in the company during this research. There were no structured interviews held to answer this question, however the Head of Warehouse, Logistics Manager, Director Purchasing and Jeroen Ebbelaar were consulted on the topic.

- The answer to the main research question is formed by combining the conclusions on the different sub questions and the experiences picked up during this research.

### 1.8 Report outline

In Table 1-2 is shown which questions are answered in each chapter. Chapter two deals with the theories in the field of performance measurement, performance management and organizations. It will apply these theories to describe the organization. Chapter three answers sub question one and describes the agreements that are part of the contract with important supply chain partners like suppliers and transport companies. These agreements can be used to measure performance. Chapter four describes which departments already measure performance related to logistics and what they measure. Chapter five lists the requirements on performance measurement. These requirements stem from literature, from interviews held at the different departments as well as from the insights of the researcher through the analysis of business processes at Damen. At the end of chapter five the metrics are presented in relation to the processes of Damen. Chapter six takes two measuring points from the system to determine the performance on those points. Due to a lack of data performance on other points is not possible to determine yet. Chapter seven is divided among two topics: implementing performance measurement and using performance measuring to manage the performance. Chapter eight draws conclusions and gives reflection including on the research including recommendations.

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<th>Chapter</th>
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2 Theoretical background

This second chapter gives a foundation on the need for performance measurement at Damen and some guidelines that should be applied in a performance measurement system. The first paragraph is about the formalization that is taking place at Damen. This development is explained with literature on organizational development and growth. The second paragraph focuses at forces that are within the company between different departments and within departments. Again explanations are supported with literature, but also the organizational diagram of Damen is used as the chosen model has some specific tensions incorporated. The third paragraph gives some more description on the environment of Damen. This leads to a conclusion on complexity. Paragraphs 2.5, 2.6 and 2.7 explain what a performance measurement system is, what elements there are to a performance measurement system and what characteristics the measures should have. These three paragraphs are used to design a framework that is presented in paragraph 2.8. Paragraph 2.9 gives a conclusion to this chapter.

2.1 Family business

First must be considered where Damen originates from. The company was started in 1927 by the predecessors of the current chairman. Today the company is still family owned with Kommer Damen as president of the company holding a majority of the shares. The other shares are owned by his children. The way an organization is managed and steered is influenced by the pressures applied by the shareholders. When shares are traded on the stock exchange there is more market pressure and more need of formal control. Anonymous shareholders are more focused on increasing profits of the company and on increasing share value than when a company is a family business. In a family business the shareholders are closer connected to the product and the company. Because of this connection to the product and company and the fact that there is a long term relationship, decisions are often more based on emotion and instinct than on ratio while a public owned company shows little emotion and is rational in profit maximization.

Although in theory the strategic top of an organization with a division structure wants to have standardization of output to compare the divisions with each other and to have easy control over the results, at Damen this performance measurement is less of an issue because the company is still family owned and the entrepreneurial skills of the strategic top conflict with standard performance measurement. An example is a strategic decision about Damen Shipyards Okean. Several scenarios were calculated to figure out whether the yard was still a good investment. In all scenarios the minimal set return on investment was not achieved so the conclusion should be that the yard was sold. However, Kommer Damen took another decision because his entrepreneurial skills were conflicting with the numbers of the study. The numbers were wrong or at least it should be possible to achieve the minimal target set of all the yards of the group according to him.  

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5 Interview with Martijn Veldhuizen, Logistics Manager, on Friday October 24, 2008.
2.2 Formalization

This section explains the fact developments are currently taking place at Damen. In section 1.4 a description of the problems with logistics at Damen is given. An example of one of these shortcomings is the situation at the warehouse of Damen in the summer of 2008. While ten years ago the warehouse was managed by experience and the employees knew what to do; today the warehouse is too large and the volume of goods handled is also too large to act purely on experience. Therefore more formal procedures and formal documents are introduced (e.g. pick reports, location numbers, and barcode scanners). These formal procedures make it possible to measure performance; hence more information is becoming available.

This argumentation is supported by Mintzberg (2003) and Blau and Schoenherr (1971) as can be seen in Figure 2-1. The framework shows what the effects of growth are on an organization. The green box highlights the fact that a growing organization makes more use of planning and control systems. The fact that planning and control systems are more used springs from the fact that there is more need of coordination between units while at the same time units get bigger.

At Damen the developments shown in Figure 2-1 can be seen in practice. There are not many more levels in the hierarchy but division of labor has become stronger.
Units have become bigger to make it possible to do the same tasks for more ships and the responsibilities per function are narrowed.

As can be seen in Figure 2-2 there are several coordination mechanisms available to a manager. A growing span of control makes it more difficult to use the coordination mechanism direct supervision. Next to direct supervision are several coordination mechanisms located that focus on standardization. Standardization of work processes and output enable measuring processes and steering on numbers which is not suited for direct supervision. Therefore it is logical that with a growing organization as the case with Damen, span of control of managers increases and standardization of output and measuring of performance increase in importance to manage the span of control.

![Horizontally centralized to Horizontally decentralized](image)

**Figure 2-2 Coordination mechanism continuum. Source: Mintzberg (2003)**

Systems for the control of results are mostly applied where interdependence in its form of common facilities for units can be found, hence when grouping of units is based on markets (Mintzberg, 2003). A strong example of interdependence is the warehouse of Damen. All the different product groups use the same warehouse space and the same employees. The operations in the warehouse depend on the planning of the product groups. The product groups should assign priorities to some handlings and should also communicate which projects have a lesser importance because of a change in schedule. If they do not do this, the employees in the warehouse must decide what should get priority. The product groups are the customers of Logistics at Damen and should thus proclaim their needs.

When units are grouped, the intragroup coordination increases while the consequence is that intergroup coordination decreases (Mintzberg, 2003). This can be seen at the Work Preparation of Damen. When work preparation is taken as an example it shows that the people for one product group have tight coordination between them, while there is less coordination with employees of work preparation assigned to other product groups. The fact that there is no adaptation with other product groups working at Work Preparation has its effect on the resources that are shared like the warehouse, Transport Coordination and Expedition.

When direct supervision is compared with standardization for the purpose of coordination, the latter will result in larger work units (Mintzberg, 2003, pp. 71). Standardization is becoming a bigger issue at Damen. Some examples of this are the fact that Cargo Vessels is starting to use the ERP package that is used by most product groups of Damen: Mars. The work processes of Work Preparation are becoming also more uniform when compared between the different product groups. The larger an organization gets; the more extensive the structure, i.e. the more specialized the tasks, the more differentiated the units are and the more developed the managerial component is (Mintzberg, 2003, pp. 130). The larger an organizations grows, the more formalized the conduct becomes (Mintzberg, 2003, pp. 132). Formalization can once again be seen in the warehouse of Damen. The employees now have to pick according to a picking list where they did not have to use such a list before. At the same time it can be seen that the managerial component is being developed. More students from universities start working at Damen and work their way up into management positions. They are more familiarized with modern managerial styles and tools than the managers that come from production positions.
The company is in a transition to a more professional managed organization triggered by the fast growth of the recent years. The development of the managerial component is moreover reflected by the structured meetings held between the head Warehouse, Logistics Manager and the project managers supported by sheets with hard data.

According to Gunasekaran and Kobu (2007) “good performance measures and metrics will facilitate a more open and transparent communication between people leading to a cooperative supported work and hence improved organizational performance”. So there exists a possibility that with performance measurement Damen will be less dependable on tacit knowledge of the workers. A lack of communication is seen as one of the biggest problems within the organization according to the people interviewed in this research. However, it must be recognized that Gunasekaran and Kobu both have an engineering background and that scholars specialized in organizational structure have other ideas. De Bruin (2002) points out that performance measurement can lead to perverse effects because it reduces complexity to one single dimension. When employees are forced into performance measurement they might try to obstruct it or they will assure that they reach their targets, but are not willing to cooperate more than that. Therefore it is important that employees see the benefits of performance measuring.

The conclusion of this section is that Damen is trying to formalize triggered by the developments of the company, based on the recent rapid growth, coping with the constraints on the span of control of the managers. Managers see formalization as a means to increase the span of control of single managers and to keep tight control over the different processes.

### 2.3 Forces of Mintzberg

The positioning of a company and its structure is triggered by several forces (Mintzberg, 2003). The top of a company generally wants to centralize the power at the top. Middle management will try to keep their power and will do this by trying to create divisions ruled by them and stimulated by standardization of output. The operators of a company will try to decentralize in order to have more autonomy in their work. These three forces are all in the line of production. Then there are two additional forces of parts of the company that are not in the line. First there is the technostructure that will try to standardize. An important part of the technostructure is the standardization department of Damen: Standata. The last force in a company will try to achieve cooperation and is stimulated by the cooperative services of the company.

![Organizational model](image)

**Figure 2-3 Organizational model. Source: Mintzberg (2003)**
2.3.1 Professional bureaucracy
The organizational structure of Damen can be classified according to two of the basic designs made by Mintzberg (2003) based on the previous forces. First Damen has clear elements of a professional bureaucracy. The primary coordination mechanism of the professional bureaucracy is standardization of skills which can be seen in Figure 2-2. The most important part of such an organization is formed by the operators. In Damen it can be seen that the operators can act quite autonomous. This results in different construction sequences of ships. Decentralization is then both horizontal and vertical. Decentralization is horizontal because a foreman building one ship has its own working methods and is not hindered by working methods of another foreman working on another ship. The vertical decentralization is acknowledged by the fact that foremen can determine what the building sequence is, not obliged by a work breakdown structure forced on them by management.

2.3.2 The divisionalized form
The second organizational structure of Mintzberg (2003) of which Damen shows severe similarities to is the divisionalized form. Within the divisionalized form the primary coordination mechanism is standardization of output which is a little bit more horizontally centralized than standardization of skills as can be seen in Figure 2-2. The most important part of the organization in the divisionalized form is middle management. The fact that middle management takes such a strong position is easily understood. The divisions are managed by managers that want to manage their divisions with their own styles, not hindered by top management telling them what to do. A good example of this is the Cargo Vessels division of Damen. This division is currently integrated within the Damen structure, forcing them to work with the same IT systems as the other divisions which would be an example of a force to standardization triggered by the technostructure. However, most of this division is acknowledged for the fact that there is a strong centralization of power at the head of the division. The head of the division will take the decisions with which yards cooperation is needed, where ships are built, and how work processes are performed. Top management gives him the authority to make its own decisions as long as the goals of the company are obtained and the division is making profit.

The same kind of autonomy can also be seen at the Logistics Manager. Top management gives him room to manage the logistical department as suits him. At the same time he tries to keep firm grip on the department. Even though the department has grown and several management layers are added, the Logistics Manager still keeps tight control over the operations on the work floor while there is also a supervisor responsible. The style of management of the Logistics Manager is in this regard similar to the style of management of the Product Director of Cargo Vessels, although Logistics is not a strict division, but a department.
2.3.3 Organizational chart

![Organizational chart]

Figure 2-4 Organizational chart Damen Shipyards Gorinchem. Source: Damenplein

The consideration of the similarity between the management style of the Product Director of Cargo Vessels and the Logistics Manager can be explained based on the organizational chart of Damen Shipyards Gorinchem. As can be seen in Figure 2-4 there is a matrix structure in the company with on top the product groups and on the rows are the functional departments located. One of these columns falls under the responsibility of the Product Director Cargo Vessels and two of the rows (Logistics support and Warehousing) fall under the responsibility of the Logistics Manager. In a matrix the position of a manager of a row is comparable with the position of a manager of a column, be it the case that columns are seen as more important than rows. When functional departments would be seen more important than product groups the matrix should be rotated to have the functional departments on top.

Earlier the statement was made that middle management is the most important part in a division structure. The organizational chart of Damen highlights this with the fact that the Product Directors are located higher than the board of executives. The
reason of the specific shape of the organizational chart of Damen is that the customer is seen as most important of all. Therefore it can be said that the more traditional organizational chart is put upside down.

Other conclusions that can be made based on the organizational chart is the fact that top management contains only three positions while middle management consists of eleven or twelve positions (depending on whether you count positions or persons as Martijn Veldhuizen is head of Warehousing and Logistical support). So there are four times as many positions on middle management as there are on top level. However, this is only the case when the sales areas are neglected as middle management. When they are also seen as middle management the total number of positions would be fifteen which is five times as many as on top level. Therefore the statement that middle management is most important at Damen is reinforced.

2.3.4 Tensions

With the descriptions in this paragraph several tensions that should occur in theory can be identified. These tensions are a consequence of the matrix structure as shown in Figure 2-4 and the fact that the organizational structure of Damen falls in between a professional bureaucracy and the division structure.

Tensions from the organizational structure:

- The matrix leads to a power struggle between the product directors and the managers of the functional departments. This is evident at the matrix because two lines of authority are conflicting, especially when the managers of both the row as the column are dominant personalities.

- There is a tension between the centralizing power of middle management and the decentralizing power of the operating core. Middle management wants to have control over the projects while the foremen want autonomy in their work. Middle management is mostly concerned about running their department and finishing projects on-time, within budget with steady quality while foremen want to make their own decisions and use their own experience.

- The top of the organization tries to keep the organization as one whole so they want to centralize more decisions and will try to limit the power of middle management by enforcing work methods and IT usage. At least when the middle management is narrowed down to the product directors. In this sense the top of the organization is triggering standardization just as the technostructure does.

2.4 Complexity of logistics at Damen

Damen has to deal with rapid growth, the internationalization of the organization and the fact that the organization is highly dependable on the professional knowledge of its employees. On top of that processes often are not executed in a linear way although they are prescribed that way and administrative systems require linearity. Furthermore the customer order decoupling point is not fixed (Silvius, 2008) which is reflected by the often heard statement that Damen is a sales driven organization. Hence, the production system of Damen can be: make-to-stock, make-to-order or even engineer-to-order. A project of one ship can be in the first few months build according to make-to-stock while ending as engineer-to-order because of the extensive specific adaptations required by the customer. Some departments might see the production system as completely engineer-to-stock; however some ships are built in series at which point engineering can copy all the drawings, until the ship is sold.

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6 Linear means sequential and without feedback loops or iterations.
Inflexibility in the administrative systems leads to the use of loopholes to get things done. Proximity of activities in the warehouse lead to simple mistakes causing parts to go missing in the warehouse and causing parts to be send to the wrong countries where the parts are seized by customs because of deviations between the shipping papers and the actual goods in the containers.

Building sequence of a ship is not strictly linear which on the one hand creates flexibility while on the other hand it adds complexity because foremen all have their own preferences and professional autonomy.

The fact that ships are often one-of or only produced in small series leads to the fact that parts are also specially engineered to fit on a ship. This causes inflexibility in the sense that these parts are not easily substituted. If a part goes missing or breaks down a new order has to be placed for the new production of the part.

Table 2-1 Complexity at Damen

<table>
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<th>Reasons of complexity at Damen</th>
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<td>Customer order decoupling point</td>
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<td>Professionalism</td>
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<tr>
<td>Nonlinear</td>
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<tr>
<td>Growth</td>
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<tr>
<td>Proximity</td>
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<td>Limited substitutions</td>
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<td>Indirect information</td>
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<td>Limited understanding</td>
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<td>Inflexibility</td>
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<td>Organizational structure</td>
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<td>Resistance to change</td>
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Customs regulations differ all over the world. Building more in diverse foreign locations results in more different customs regulations to be dealt with. Customs regulations for Brazil differ from the regulations within the European Community, with the regulations for Cuba, with regulations for the Arab Emirates and with the regulations in China, Vietnam and Indonesia. Even within China the regulations differ per region. There are possibilities to have special Customs regulated warehouses, which could be a benefit, but might also have negative effects on the interchangeability of parts between different projects. Also a ship built on a yard
might be completed at another yard because the river on which the yard is located is only accessible during a few months. Parts cannot be easily transferred from one location to another because of the customs regulations.

The only conclusion that can be made at this point is that Damen has to deal with a very complex logistical environment. This complexity stretches from the material identification until the physical supply streams to the yards and the organizational structure within Damen Gorinchem. There are so many influences on the performance, not one employee is able to deal with all these influences and have the proper entire knowledge about it. Table 2-1 gives an overview of all the factors contributing to the complexity at Damen.

In the first three paragraphs of this chapter it has become clear that Damen is transitioning into a more formalized company caused by the rapid growth with production locations in foreign countries and all the aspects related to it. The organizational structure, the matrix amongst others, leads to several tensions. To deal with these tensions and the added complexity that is described above, it can be concluded that a system is needed as support for management to base their discussion on. It can be used as a support to discussions about business development as well as for operational steering of the logistical departments. This system should be a performance measurement system supportive of all the activities related to the logistics of Damen. The rest of this chapter deals with the format of such a system.

2.5 What is a performance measurement system

Neely et al. (2005) use three different definitions regarding performance and measures/measurement:

- “Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action.”
- “A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of an action.”
- “A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions.”

So with a performance measurement system a manager is able to define the efficiency and effectiveness of action. This action can be many things, however most logical are the processes within a company, or between a company and its supply chain partners. At the moment the Logistics Manager at Damen is not able to determine objectively what the efficiency and effectiveness of his actions is.

2.6 Elements of a performance measurement system

According to White (1996) two basic questions are always needed with measurements:

- What will be measured?
- How will it be measured?

Although these two questions are undoubtedly important, it is not enough. One question should be added:

- What is the purpose of measurement?

Without this last question an organization might increase bureaucracy without any real achievements in its business. Just keeping track of figures and numbers without a clear purpose is senseless. Purposes of measurement can be very diverse. It can be to increase efficiency of a measured process, to boost output or even to increase the span of control which flattens an organization and will therefore increase the efficiency of the organization as a whole. The purpose of measurement at Damen is to get more grip on the logistical performance in its broadest sense. With performance measurement there will be less fire fighting and more proactive actions.
possible. Managing will be supported and it is the efficiency and effectiveness of decisions and actions that have to be determined. Per metric it is important to acknowledge a specific purpose as well.

According to Mentzer and Firman (1994) (cited by Stainer, 1997) four aspects are part of performance management in logistics:

- information systems, both for gathering data and reporting performance,
- performance measures,
- variance analysis,
- corrective action.

These first two points have similarities with the basic questions of White (1996) as described above. The performance measures are the answer to what will be measured and also how it will be measured. The information systems in the first sense refer to how it will be measured; hence data gathering is part of how it is done. Mentzer and Firman do however go further than White. Not only addressing where data comes from, but also addressing what is done with data in the sense of reporting and taking corrective action as well as variance analysis. At the end of this chapter a framework is given that captures these elements among others. The rest of this paragraph will shine more light on the different kind of elements.

2.6.1 Perspectives

Much has been written about performance measurement in production organizations. Traditional literature on performance measurement focused mostly on financial measurements. This focus changed from 1992 when Kaplan and Norton published their well-known article: “The Balanced Scorecard – Measures that drive Performance”. According to this article apart from a financial perspective (how do we look at shareholders?), three additional perspectives are needed to determine the performance of a company.

1. Customer perspective – how do customers see us?
2. Internal business perspective – what internal processes must we excel at?
3. Innovation and learning perspective – how can we continue to improve and create value?

The customer perspective is tightly connected to the strategy of the company. A company can have a strategy to be a cost leader, to excel in product quality, to have a leading market share, or to have a leading edge in customer satisfaction. All these examples aim at increasing sales to customers. The customer perspective can therefore be classified as a goal while the internal business perspective would serve as a means, hence the internal processes of a company should be tailored to fit the strategy of serving the customer. When the yard or the product group is seen as the customer of the logistical department of Damen the logistical process is the internal process in which Damen should excel. The focus is on getting the right parts at the right moment on the right place in the right conditions.

The innovation and learning perspective is interesting when a company is investing in new markets, either geographical or product markets. While a company in a steady market should always seek for new business opportunities to increase revenues, margins or sales, the innovation and learning perspective gets a new side when a company is changing its structure to manage the increase in sales, number of employees and growing production locations. Innovation of processes is more important in a growing organization as it is hardly ever possible to keep the processes at ease and still have a manageable span of control.

The next passage in the article of Kaplan and Norton (1992) is especially interesting for the learning perspective of Damen:
“A company’s ability to innovate, improve, and learn ties directly to the company’s value. That is, only through the ability to launch new products, create more value for customers, and improve operating efficiencies continually can a company penetrate new markets and increase revenues and margins – in short, grow and thereby increase shareholder value.” (highlight added by the author of this report)

The innovative and learning perspective is supported by this research because performance measurement and performance management is an improvement focused on higher efficiency. As indicated in chapter one the goals of the problem owner are to steer the performance of Logistics and to improve the processes where the performance is lacking. It are the daily processes and cooperation between departments and business units that give room to large improvements, even acknowledged within Damen but not yet fully utilized.

2.6.2 Delivery reliability

An example of a non-financial measure is delivery reliability. Although it seems at first glance that everyone understands what determines delivery reliability, in practice it is quite hard to determine. Also it should be taken into consideration that delivery reliability can be seen at every place in the supply chain that a delivery takes place. Therefore this is also mentioned in the next paragraph.

Steward (1995) (cited by Gunasekaran, 2001) identifies three parts which together form the delivery reliability:

- delivery-to-request date;
- delivery-to-commit date;
- and order fill lead-time.

The strong point of these three parts is that it acknowledges the fact that the request date from the customer is not always the commit date. A customer often wants a product sooner than the normal lead time. At Damen this situation can be detected also. It occurs that the purchase department requests the delivery of a part within four weeks from placing the order while the standard lead time of the supplier is six weeks. The commit date is then six weeks after the placement of the order while the request date is four weeks from the moment the order is placed.

Soepenberg et al. (2008) identified two aspects that are important when considering delivery reliability:

- average lateness;
- and variance of lateness.

Still, even with the theories described above the delivery reliability of Damen cannot be determined. Because a delivery of parts to a yard consists of many different parts, the completeness is very important. If a part is not in the delivery as it should, it could be the case that the missing part leads to stagnation in the activities at the yard because of the fact that it is crucial. On the other hand it could be the case that the missing of the part does not lead to any problems and that it can be included in the next delivery moment. That is why determining delivery reliability in hard numbers is very hard and perhaps purely quantified objective measurement is not enough. A solution to this problem could be not to measure the lateness of a delivery (i.e. a container or a truck), but the average lateness of single parts. In that case there are no parts missing; only parts those are (infinite) late.

2.6.3 Supplier performance

Four key elements exist when considering the relationship between the assembler/manufacturer and his suppliers (Womack et al., 1990):

- Price
- Quality
• Delivery reliability
• Contract length

These key elements were originally identified for the automotive industry and they should be applicable to the shipbuilding industry as well. However some remarks have to be made. The automotive industry is acknowledged for a steady stream from suppliers to the assembler because many reproductions are made of a single car. Shipbuilding also has series, just like cars have, but these series are smaller and the period it takes to complete ten ships is far longer than the period to complete ten cars. This should have its effects on contract length mainly, but also on delivery reliability and the weights of the four elements on the total.

Delivery reliability differs at shipbuilding from the automotive industry because there are not so many frequent deliveries to the assembly plant or shipyard. It is more common to have goods stored at the site for a couple of weeks. This can be defended by the fact that it takes many months or even years to build a complete ship while it takes only hours to build a complete car. Therefore the proportion from total building time to the time in inventory of a ship is not that high. On top of that it must be acknowledged that the suppliers in the ship industry produce are smaller sets than suppliers in the automotive industries which leads to longer lead times.

In Damen everything is aimed at delivering the ship to the customer at the agreed date. Delivery reliability towards the customer is seen as most important. Therefore the delivery reliability of the supplier is so important, especially when just-in-time delivery is applied. Price is clearly less important than delivery reliability, which is reflected in the high costs for urgent deliveries and the use of air transport. Quality however is also seen as very important. When Damen uses a new yard it will do everything to assure the yard will deliver the same quality as all the other yards of the group. The organization wants to keep hands on the quality of the final product. All kinds of certificates have to be issued. This certification begins at suppliers, if their products are not certified; the ship will not be certified. Chapter three gives more details on the certificates that should be part of the delivered products. Contract length is not a big issue at Damen. In many cases there does not even exist a contract with the supplier. More about contracts with suppliers will be discussed in the next chapter.

2.6.4 Financial elements

Traditionally most performance measures used data from the balance sheet and the profit and loss account. The first change in this approach was by the introduction of activity based costing developed by Johnson and Kaplan (1987) (Tangen, 2004) or by Cooper (1987a, b, 1988a, b, 1989a, b) (Neely et al., 2005). This new approach required a different calculation method and needed extra handling to calculate. Also additional measurements were needed because the input for activity based costing cannot be found on the balance sheet. Activity based costing calculates the costs of each activity. This way a company will know what it costs to drive fifty miles further or to keep an item longer in stock. By having more details on the activity it becomes possible to make the indirect costs more direct. For instance, the costs of the warehouse can be assigned according to the use of the warehouse. If one project demands more capacity of the warehouse, it will also bear a larger share of the costs of the warehouse. This can of course be on a lower level containing much more detail and accurateness.

Although activity based costing is associated with manufacturing performance, there does not exist a direct relationship between activity based costing and return on assets according to an intensive inquiry (Ittner et al., 2002). Only indirect return on
assets is influenced by the increase in quality and reduction of lead times that are accomplished with activity based costing. In the rest of this research activity based costing will be left out. At the moment delivery reliability in its broadest sense is seen far more important than costs reductions. Choices have to be made when introducing performance measurements. The choice is made for more focus on the delivery reliability and throughput times. Perhaps in the future it is possible to upgrade to activity based costing, but only when the added value has been proven.

### 2.7 Characteristics of measures

It is important to have a list of characteristics that should be applied to a performance measurement system and the metrics designed for Damen. These characteristics influence the effectiveness of the performance management system. By taking care of these characteristics the usefulness and user friendliness of the performance management system is increased. These characteristics are based on how people perceive numbers and their ability to interpret numbers.

a. Quantitative (Coyle et al., 2003)
b. Consistent with overall strategy, support strategic objectives (Coyle et al., 2003) (Tangen, 2004)
c. System is limited to most important aspects (Coyle et al., 2003) (Tangen, 2004)
d. Uses economies of efforts (Coyle et al., 2003)
e. Objective rather than subjective (Globerson et al., 1985, cited by Neely et al., 2005)
f. Ratio rather than absolute number (Globerson et al., 1985, cited by Neely et al., 2005)
g. Easy to understand, visible, easily accessible (Coyle et al., 2003) (Tangen, 2004)

Ad a. A measure should be quantitative. A quantitative measure is first of all more objective than a qualitative measure and second of all there are a lot of possibilities at Damen to use quantitative measures.

Ad b. The measures should support the strategic objectives of Damen as well as the objectives of the different product groups. Furthermore, it is not enough to take only the strategic objectives. Logistics is a very operational matter and there should be a focus on the operational processes (see paragraph 2.6.1).

Ad c. Only what is important for the performance should be monitored. Monitoring can never be a goal; it should always be a means to an end.

Ad d. Using economies of efforts means that the benefits of the data collection and data analysis outweighs the costs of collection and analysis. Because the system of Damen is more complex than production systems that are based on conveyor belts, it will be harder to determine upfront if data collection of a single measure will reap more benefits than costs. However it can be said about the total performance system, especially when it is seen as an iterative process that is adapted with new insights.

Ad e. To have fewer discussions about performance it is better to have objective measures. It should be kept in mind although that measures that seem to be purely objective at first glance will be debatable caused by the accurateness of the sources that are used to derive the data.

Ad f. With volumes that differ every month it is better to compare relative numbers (ratio) than absolute numbers.

Ad g. It is important that discussions about the measures be kept to a minimum, so it should be easy to understand. However, because there will be someone in charge of data collection and someone in charge of managing based on the outcomes, it really is important that those people understand the measures and that they can clarify them to others that are affected by it. When taking
one of the goals in mind stated in chapter one, it is important that managers of which departments influence the logistic performance understand the measures presented to them by the Logistics Manager.

2.8 Framework

Performance management and performance measurement are closely related as can be seen in Figure 2-5. To manage a company or processes within a company it is useful when measurements are available. The framework in Figure 2-5 is actually performance management. It shows that measurements have to be compared with goals and norms as set by management and that differences can lead to actions. The performance is determined by using metrics based on key performance indicators and measurements springing from business processes. Often this information will be available in the ERP package of Damen (Mars), although it could also spring from other sources. Another possibility is that data is not on hand in which case management has to decide whether to gather the data in a system or to choose another performance indicator closely related to the one previously determined. The outcomes of the measurements put together determine the performance. How often this performance has to be determined and reviewed determines on the importance of the process and the speed with which the performance can change. According to Neely et al. (1997) it is also important to address who is responsible for gathering data, calculating the results on the metrics and taking action when performance is not how it should be. If these issues were not addressed the performance measurement system would not have any purpose. Measurement is taken to manage processes.

![Figure 2-5 Framework of performance measurement and management. Source: author](image)

The arrows in Figure 2-5 represent the flow. Metrics is combined with data the input for the calculation process. Calculations compared with goals and norms leads to a specific performance. Based on this performance action has to be taken when performance is not in an optimum, or when there is a chance that performance will worsen if actions are not taken. The dashed arrows represent the feedback and will not always be part of the system. Actions that are undertaken will have result on the performance. To determine this result measurements have to be made. The other dashed arrow represents the fact that management perhaps changes its goals and wants track on other performance indicators. In this case new metrics will have to be
added or metrics will have to be deleted. The blue ovals indicate aspects that need attention.

The double arrow head between logistical performance and goals/norms represents double-loop learning as described by Argyris and Schön (1974). According to their research it is not enough to compare the founded value with the goal, it should also be questioned whether the goal was set right. It could be the case that a goal is too ambitious or that learning effects lead to outdated norms, so norms should actually be tighter. It enables the continual learning which connects to the innovation and learning perspective as described in paragraph 2.6.1.

2.9 Conclusion on theory
This chapter has shown the need for a performance measurement system based on the developments of the company. Rapid growth of a company leads to specialization and increased span of control. Combined with the organizational structure of Damen, the matrix in which the functional departments are inferior to the product groups, there are constant discussions about the performance exceeding the boundaries of the different departments.

The performance of Logistics is stressed by the input of other departments, limited time span, consequences of internationalization and globalization, difference in requirements set by the customers of the logistical process, hiring of new personnel and dependability on many suppliers.

Both for business development purposes as for operational steering purposes it would be best if clear performance indicators were available. The number of indicators should be limited to assure that performance measuring will provide net benefit; hence costs of measuring should not outweigh the benefits of measuring. The main focus of the performance measuring system should be at delivery reliability throughout the whole supply chain. The outcomes of measurements can be used in a learning perspective chasing continuous improvements. Enabling good management capabilities will require the performance measurement system to give insight in to average lateness and spread in lateness. To assure that on-time delivery does not go at the expense of quality there has to be focus on quality as well. Clear measures should have certain characteristics to enhance understandability. Finally a framework (Figure 2.5) was presented in this chapter that should be used for each measure dealing with all the necessities.
3 Purchase

Logistics at Damen does not start at Purchase but actually starts at Engineering. Figure 3-1 shows a simplified form of Figure 1-3. The processes before Purchase should be part of the performance measurement system. The reason that Purchase gets special attention in this chapter is that Purchase handles the contracts with the suppliers and is responsible for communicating the logistical requirements to the customers. The goal of this chapter is to answer the following question: “what agreements are made between Damen and its supply chain partners (i.e. suppliers of goods and suppliers of services) considering logistics?” The relevance of this question springs from the fact that the agreements made with the suppliers might contain elements that should be part of the performance measurement system on the one hand and on the other hand it will give insights on what points Damen has to pay extra attention to safeguard the logistical process.

![Figure 3-1 Sequence. Source: author](image)

3.1 Role of purchase

The purchasing department of Damen is responsible for all the purchases that are done to build a boat. It is a challenge to receive all the parts in time to assure the building processes will not stagnate and at the same time have good agreements with suppliers. First of all this challenge is caused by the fact that Purchase can only start ordering when Work Preparation has handled over the parts lists. Still Purchase has to make exceptions to this to assure on time delivery of the so called long lead items as discussed in the introduction. The second reason for this challenge is that balancing with delivery moments springs from the fact that it is not useful to receive some goods on time making high costs, while other goods are not available at that moment and should be mounted on the ship at the same time or even earlier. That is why according to the Director Purchasing it does not always make sense to invest in the highest delivery reliability. Why flying in parts if other parts are not available yet so the flown in parts will have to wait at the yard?

The fact that the purchasing practice is so complex, there are many factors all interrelated, is the main reason that is given by the Director Purchasing for the fact that there are hardly any real tough agreements with suppliers as part of the contracts. It seems more successful to have a more gentile and friendly approach to stimulate suppliers in their performance according to the Director Purchasing. The fact that there are not many hard agreements in the contract does not mean that performance of suppliers is not determined. Track records and evaluations are performed internally by Purchase in cooperation with the other departments of Damen.

In almost any industry and service industry service level agreements (SLA) are applied. It seems a proven concept to improve the performance of the supplier-buyer relationship. It is questionable why Damen has not introduced SLAs in their normal relationships with their customers. However, according to the Director Purchasing Damen does not have SLAs. It seems that Damen is somewhat behind on business
development compared to other industries. However it can be the case that the whole shipbuilding industry is behind on other industries. Benchmarking falls outside the scope of this research however.

3.2 Purchase process

There are several distinctions between goods possible. First there is a difference between the Damen Standard Articles (DSA) and the Project Components (PC).

“Damen Standard Article, all items which are defined by means of a DSA-number.” (Handbook TQM, 2007)

“A Damen Standard Article is a component which in principle is used on different ship types and which is defined in a DSA-file of the logistical program.” (Definitie DSA 071105.doc)

“A Project Component is a component that is defined for/within a ship type for/by the departments drawing room, logistics and purchase. The definition is set in the logistical program. A Project Component is not suitable for different types of ships. If a component would be used on different ship types, it should be recommended to make it a DSA.” (Definitie DSA 071105.doc)

The main benefit of DSAs is that the handling of the articles can be done much faster than with PCs. In the ERP package the weights, prices, supplier and other specifications of DSAs are saved. PCs have to be weighted in the warehouse and the information has to be handled administratively. It is very important to keep the database containing the DSAs up-to-date. If a supplier adapts its prices or when the product is changed slightly and these changes are not registered in Mars, customs will seize the goods when they are transported to for instance China. Not only the activities in the warehouse are performed faster with DSAs, other departments face comparable benefits as well. Work Preparation does not have to identify the part and specify it. DSAs can be put on the drawings and attached parts lists by Engineering. Purchase has the advantage that they know exactly what they should order. With a PC it can be tricky to order the right product and to find a good supplier for it.

Second DSAs can be subdivided in:

- goods that are in stock,
- seize goods and
- goods that are special ordered for a building project.

The only difference between stock goods and seize goods is the location where they are stored. Stock goods are kept in the central warehouse and seize goods are kept in the production warehouse, both in Gorinchem. PCs are always bought for a specific project. The relation between the goods can be seen in Figure 3-2.

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7 Translated from Dutch by the author.
8 Translated from Dutch by the author.
Two purchasers are together responsible for up-to-date prices of DSAs. The stock goods and seize goods are bought by them when they run out of it. These last two kinds of goods are low value high volume goods like nuts and bolts. Project components and DSAs that are not kept in stock are ordered by purchasers that are assigned to a specific project; each project got its own purchaser. Long lead items which are bought on building number as well are bought by the Director Purchasing based on the HKS (high priority list which contains ships that probably will be built within a certain time frame).

Most of the goods are bought for a specific project. These goods can be ordered by the purchase department once Work Preparation has compiled the parts list and Purchase has selected the most suitable supplier. Usually the order contains a preferred delivery date that might be the same as the standard lead time of the supplier, but often will deviate from it. Only when goods are not yet delivered, i.e. the goods are not yet administrated in Mars as received; Purchase will get an automatic generated announcement that the goods are late. Goods that are delivered directly to a yard are not registered as received in Mars, so this causes problems. Furthermore so many deviations occur that the list of announcements is too long to handle according to the Director Purchasing. The problem with this is that other departments like Warehouse, Work Preparation and project management are left with the problems of late deliveries. A solution should be founded to assure improvements of on time delivery by the suppliers. More detail on the standardized purchase process can be found in appendix F.

### 3.3 Suppliers without contractual agreements

Several contracts were studied to determine if these contracts contain elements that deal with the logistics of Damen. Not all important suppliers operate on the basis of contractual agreements. Although the suppliers in paragraph 3.6 are all suppliers of goods needed to build ships, the suppliers given here as an example are not suppliers of goods, but suppliers of services. This is done because these suppliers are very important to the success of Damen in its core business. Unilash for instance, a company which employees are hired to fill containers, just sends an invoice for every time their service is used. When Unilash employees are needed an order is placed and Unilash responds by sending employees. Afterwards an invoice is send by Unilash and paid by Damen. There are no agreements that oblige Unilash to deliver or to respond within a specific time interval which would be typical topics in a service level agreement.

With the most important transport company that picks up the container, sometimes stores them and finally delivers the containers to a shipping company in the harbor of
Rotterdam is also not a contractual agreement. However, this contact is so good that disputes are not the case and both companies do their at most best to respect each other’s business processes and go the extra mile to obtain a high service level.

These two important suppliers are only a small example. Because Damen uses hundreds of suppliers and often these suppliers are very small companies, it occurs regularly that there is no contractual agreement or framework before ordering. Only with the larger suppliers there are contractual agreements of which Nederlandse Radiatoren Fabriek B.V., Econosto, Reintjes GmbH. Pon Power and International Paint are discussed in paragraph 3.6.

3.4 General Purchase Conditions

In all contractual agreements with suppliers Damen refers to the “General purchase conditions of B.V. Scheepswerf Damen Gorinchem” as registered at the Chamber of Commerce. The general purchase conditions of Damen overrule the conditions of the suppliers. Only the bilateral contractual agreement between the supplier and Damen enables deviations from the general purchase agreements. Even when there is no contractual agreement made with a supplier the general purchase conditions are binding. Beneath two aspects of the general purchase conditions are discussed.

3.4.1 Delivered duty unpaid

The general purchase conditions contain many subjects which are not always relevant for every supplier. In the light of this research not all the articles in the general purchase conditions are relevant. The first relevant article is article three which is called “prices”. It states that all prices are net final prices, not including value added taxes. The more interesting topic of this article is the delivery condition: delivered duty unpaid (DDU) at the place of delivery. This means that Damen is responsible for unloading the mode of transport with which the goods are delivered. This responsibility includes the costs of unloading and the risk of unloading, hence if the goods will be damaged during unloading, this will be at the expense of Damen. It is important to realize that Damen has to order substitutes for the goods that damage during unloading and that the supplier is not obliged to deliver or put high priority to this. When DDP (delivered duty paid) would be applied the supplier would bear maximum responsibilities. With DDU Damen is responsible for clearing the goods for import if applicable while with DDP the supplier is responsible for clearing the goods for import including the consequences of possible delays with it. The general purchase conditions should be adapted to state DDP instead of DDU.

3.4.2 Delivery

Article four of the general purchase conditions deals with the fact that suppliers are obliged to deliver goods on time. If a supplier foresees he will not be able to deliver on time, he must report this to Damen in writing within 24 hours from the moment he knows he will not be on time. In theory this will enable Damen to update its planning to deal with the delayed goods.

Article 4.1 in the general purchase conditions states literally that “the agreed delivery time is of material significance”. Damen can demand from its suppliers several plans (engineering-, purchase-, main components of production-, inspection and testing-, transport plan and assembly plan on board) when the supplier works with a second tier supplier or when the supplier needs to manufacture goods. Damen also has the possibility to request progress reports from the supplier in which case the supplier is obligated to give such a progress report indicating the current situation. These

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9 Dick Thijssen, October 27, 2008.
conditions will in theory enable Damen to keep track of planning and keep control of its upstream logistics.

To assure that the goods are on time delivered the general purchase conditions state that suppliers and second tier suppliers have to do their utmost efforts to make up any lost time (article 4.5). This includes overtime in the evenings and weekends on Saturday and Sunday and hiring extra capacity.

Damen can request a supplier to postpone delivery (article 4.6). In that case the supplier is obliged to store and secure the goods properly packed and recognizable that it is intended for Damen. Damen will pay a reasonable fee for the storage at the supplier. In practice however, this is almost solely done with goods that require special storage conditions.

The supplier has to deliver proper documentation when goods are delivered, including guarantees and classification certificates and drawings, or earlier if Damen requests so. Goods that are delivered have to be marked in accordance with the regulations of Damen.

3.5 Special Terms of Purchase

3.5.1 Marking

With the orders for larger items, sets and with the use of subcontracting always Special Terms of Purchase are sent. There are several versions of this document: a general one, one for electric systems for DTC, one general for electric systems, one for isolation, one for pipe works, and one for paint jobs. Most paragraphs in these documents are about operating temperatures, voltage on board of the ship, paint on the systems, and documentation like manuals and instructions. However, there are also important agreements included for Logistics. First there is a subscription about marking of the parts. All goods should be marked with:

- Damen Shipyards Gorinchem
- Delivery address
- Yard number
- System code
- Item number
- Purchase order number.

In the warehouse the most important marking is the order number. This is used to identify the parts and to register the parts in the ERP system. Still, the other markings should be included as well. At the moment it is not clear whether the parts are actually marked according to the requirements. The employees in the warehouse are faced with the actual deliveries, but there is not feedback from Warehouse to Purchase about marking. One of the problems that seems to occur quite often is that only one box in a delivery is marked, but to assure that no parts go missing all the boxes should be marked. Only when a single supplier continuously marks its parts in the wrong way, perhaps a feedback call is made from Warehouse to Purchase.

There should be more structured communication between these departments to assure that improvements are made and that the requirements that are set by Purchase are followed by the suppliers.

3.5.2 Packing lists

There is a second paragraph of special importance considering logistics. A week prior to delivery of the parts the supplier has to send a packing list to the Work Preparation employee responsible for the ship. This packing list is an Excel document according to a template designed at Damen. The idea of the list is that
employees at Damen know what parts are included in a shipment, that they can identify the parts and that they can forward the parts to the yards if the parts are delivered at Gorinchem. Although it is a format of Damen and it could be expected that the format is sufficient, suppliers do add extra information on the excel list because they think otherwise it is not clear.

Here again is a problem with feedback. The Excel format is distributed by Purchase and returned to Work Preparation. Purchase does not receive feedback about the Excel lists and they do not need the lists themselves. It could be said that the Excel lists requires a handling done by Purchase that is not interesting to them\(^\text{10}\). Because of the shared responsibilities between Purchase and Work Preparation and in some cases Transport Coordination (depending on the product group it is Work Preparation or Transport Coordination that makes transport documents based on the Excel lists) there exists a grey area in which there is no strict control. Disruptions in the activities with deliveries are not centrally registered and continuous learning is not part of the process.

3.6 Contracts

3.6.1 Selection of suppliers

All the contractual agreements Damen has with its suppliers refer to the general purchase conditions, however most contracts also have own clauses about delivery of the goods and marking of the goods. In this paragraph the contracts with suppliers of box coolers (Nederlandse Radiateuren Fabriek B.V.), valves (Econosto), gearboxes (Reintjes), engines (Pon Power) and paint (International Paint) are discussed.

Box coolers fall in the category of primary ship systems (code 300) according to the Handbook System Code\(^\text{11}\) of Damen. Engines and gearboxes are categorized as machinery (code 200). Paint falls in the category of shipbuilding (code 100). Finally valves and fittings are used for different systems. All these products have different characteristics so they have to be treated different. Valves and fittings are standardized products so the contract is suited for this. Box coolers are interesting because they can be used for several systems, however are always early in the building process. Engines and gearboxes are typical long lead items that cannot be replaced with substitutes easily. Paint requires special storage conditions (Damen is only allowed to keep paint 48 hours in stock) and special transport conditions. If you want to ship paint across the ocean, the shipping company must allow you to transport it because there are regulations concerning the combined transport of goods\(^\text{12}\). With these suppliers and products there is a broad spectrum of goods and conditions which make it interesting to look at the contracts in this chapter.

3.6.2 Delivery

Box coolers

According to the contract with Nederlandse Radiateuren Fabriek B.V., a supplier of box coolers (a system that uses the sea water to cool diverse systems), orders need to be delivered complete and meticulous without any subsequent deliveries. The delivery time set in the contract is eight weeks after the order is placed, with the remark that earlier deliveries are negotiable.

Valves

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\(^{10}\) Dick Thijssen, October 27, 2008

\(^{11}\) For a complete overview of system codes on system and sub system level see appendix E.

\(^{12}\) John Slijkoord, June 19, 2008
The contract with a supplier of valves, fittings and butterfly valves (Econosto) has a paragraph on delivery times too. The contract contains an agreement on what is seen as standard articles that are used on ships of Damen and are provided by this specific supplier. Standard articles that are ordered before 4 p.m. will be delivered the next day in the Netherlands when requested by Damen. It also states that when it is not possible to deliver these standard items, the supplier is obligated to notify the purchaser of Damen and to take measures to prevent damage resulting from late delivery.

The terms of delivery of between this supplier and Damen deviate from the general purchase conditions. Instead of DDU this agreement is based on DDP (delivered duty paid) for deliveries within the Benelux and FCA (free carrier) for deliveries outside of the Benelux with as transfer of transport obligation Capelle aan den IJssel which is the location of the supplier.

Delivery time for non standard items is not included in this contract, however the contract is a prolongation of a former contract and it could be that there is a clause on delivery time in the former. This contract does however contain a paragraph about packing lists that have to be sent at least a week in advance, hence the above described Excel lists.

**Gearboxes**
The contractual agreement between Damen and a supplier of gearboxes (Reintjes GmbH) contains several delivery times. Depending on the type of gearbox the delivery time is set on 8, 10, 12 or 16 weeks. Because production of gearboxes is not done overnight Damen will provide a sales forecast to the supplier of the gearboxes to enable the supplier to buy material and make reservations for production capacity. The contract does however already contains a paragraph indicating that there is a shortage of raw materials so the former delivery times will be 16, 18, 20 and 24 weeks temporarily. It is questionable what possibilities Damen has if these delivery times are also not kept in case of continued shortages of raw materials.

The terms of delivery are once again divergent from the general purchase conditions; here too the Incoterm DDP is used for deliveries within the Benelux with a surcharge for deliveries outside the Benelux. This surcharge does however have to be approved upfront by the persons on the purchase order.

Next to the goods the supplier is also obligated to deliver drawings, construction-, operation-, and maintenance manuals, handbooks, brochures and pamphlets in English containing yard number to Damen within two weeks after the delivery of goods.

**Engines**
The delivery time with Pon Power, the main supplier of engines and single supplier of Caterpillar in the Netherlands, is weekly tuned between the production department of the supplier and the purchase department of Damen. In addition to the delivery time the planning is also weekly tuned between the mentioned departments. If Damen has a new ship on its high priority list the supplier will start up a project to plan the specified engine.

**Paint**
The contract with a large supplier of paint (International Paint, part of Akzo Nobel) is in accordance with the contract of the supplier of box coolers in the sense that here too the contract states that orders must be delivered fully and carefully and without subsequent deliveries. The terms of delivery are DDU for full truck loads and full
container loads for new building construction projects. When smaller orders are combined to more than 5,500 liters they are sent as group cargo on the first working day of the month. When Damen orders more than 5000 liters it has to do this at least five weeks in advance in consideration with the supplier.

3.6.3 Marking

Box coolers
In the contract with the supplier of box coolers a paragraph is included that states that at delivery, the goods have to be labeled with minimally the order and article numbers. Every subsidiary of Damen can require additional demands to this.

Valves
The contract with the supplier of valves, fittings and butterfly valves contains more requirements on marking than the contract with the supplier of box coolers. The supplier of valves, fittings and butterfly valves is obligated to mark the goods with the ordering yard, delivery address, yard number, system code, item number, and purchase order number. In accordance to the former contract, this contract also contains a line on the fact that subsidiaries of Damen can put additional requirements on the marking of the goods.

Gearboxes
The deliveries of gearboxes must contain at least the shipyard, delivery address, yard number, system code, item number, and purchase order number, just as is stated in the contract with the supplier of valves. Damen yards may demand additional marks on the goods.

Engines
The contract with the supplier of engines does not contain a paragraph on marking of the goods. However, because the supplier opens projects especially for the ships Damen builds, there is a high chance that marking is done effectively in cooperation with Damen.

Paint
The minimal marking requirement is less than with the supplier of valves is agreed. Only the order number and product/article number has to be on the goods, although here too subsidiary companies of Damen may require additional markings.
3.7 Conclusion on current contracts

With the information in this chapter it is now possible to answer the first sub question as stated in chapter 1: "what agreements are made between Damen and its supply chain partners (i.e. suppliers of goods and suppliers of services) considering logistics?"

Damen has several documents available in which they request logistical information from suppliers. The first document is the general purchase conditions which is applicable to all transactions with suppliers and can only be overruled by a bilateral contract. Another document that is used to require certain logistical performances from the suppliers is the special terms of purchase. Damen has six versions of this document, all obtaining certain requirements focused on a specific system or a specific product group. The last document that Damen has to steer the performance of its suppliers are the bilateral contracts. Although Damen has bilateral contracts with many of its important and preferred suppliers, the arrangements in the contracts are not very hard. On top of that there are very important suppliers with which Damen has absolutely no contract, while there is a high amount of money involved and when the supplier would no longer deliver the service Damen would face a huge risk. For steering performance together with a supplier a contract is not absolutely necessary, however to reduce risks it is advisable to operate on basis of a contract. Damen should recognize the risks it is taking with suppliers that have no obligation to deliver but do deliver on a very regular basis and are very important to the core business.

When the diverse documents are compared to each other the conclusion can be drawn that the general purchase conditions are outdated, at least on the terms of delivery. This conclusion is supported by Dick Thijssen of Purchase. Another conclusion based on the comparison of the documents is that there is not a single...
line with requirements on marking of the goods. The different requirements on markings that are found are presented in Table 3-1. The order number is the most important marking on the goods because that specific number is used at the warehouse to identify the goods in the ERP system. However, more additional markings can make it easier to identify goods and will result in a better handling of the goods at the sites of Damen.

Apart from marking of the goods it is very important that Damen has good arrangements with its suppliers about lead times. In the previous two chapters it became clear that delivery times are most important for the operations of Damen. Therefore it is important that Damen includes lead times in the contracts with its suppliers, or at least receives confirmation of its requested delivery moments. When a delivery moment is confirmed, Damen has the possibility to check upon this performance and can initiate in dialogues with the suppliers how to deal with lacking performance. Both late deliveries and early deliveries are not wanted, however agreements should not be too rigid as Damen needs flexibility of its suppliers at the moment the planning of a project changes. Because all the suppliers have different characteristics and deliver a wide range of products, it is not possible to have a standard lead time in the general purchase conditions. Such a document could however include an article on confirmation of delivery moments. It is important that when Damen wants a supplier to follow the requirements in the general purchase conditions that each order refers to the general purchase conditions.

Paragraph 2.6.3 named four aspects that should be part of a good contract with a supplier: price; quality; delivery reliability; contract length. As already indicated, the last point is seen as less important, although Damen should have some more focus on it as some contracts have already expired. Quality is a clear part of the special terms of purchase and the general purchase conditions which clearly has its reflections on Logistics, as the goods are inspected by Warehouse.

Purchase shares some activities and responsibilities with other departments working on logistics. Purchase is responsible for communicating requirements on marking to the suppliers, while they are not confronted with the performance on this aspect, hence Warehouse is. Also there are some shared responsibilities between Work Preparation and Purchase regarding amongst others determining when parts are needed (Work Preparation for the normal items and Purchase for the long lead items). These shared responsibilities lead to grey areas that require intensive communication. A way to reduce communication on the interfaces between departments with respect to these grey areas is writing down the performance on it. With a few simple metrics the interfaces will be better manageable. Purchase, Work Preparation and Warehouse not have to focus anymore on the events that are discussed, but will be able to communicate on the actual performance on a weekly or monthly basis.

The conclusion of this chapter is that Damen has several possibilities to determine the performance of its suppliers, but that it does not have a high priority at the moment. This is reflected by the lack of service level agreements and the outdated general purchase conditions. With good administration it should however be possible to measure the performance of suppliers based on the marking of the goods, the delivery moment and the quality of the deliveries.
4 Current practice

The goal of this chapter is twofold. First of all the following research question will be answered in this chapter: "what performance measurement on logistics is currently executed at Damen?" The second goal of this chapter is to identify what is not measured at the moment but should be part of the measurement system. This second goal will not be obtained completely in this chapter because it will be part of the next chapter, although it is implicitly part of both. This chapter will start with more detail on the planning procedure as follow up of paragraphs 1.4.3 and 1.4.4. Paragraph 4.2 discusses measurements that are performed by Logistics and paragraph 4.3 discusses the measurements performed by Purchase. The conclusion of this chapter and the answer to the above question is formulated in paragraph 4.4. This chapter contains only procedures that are followed before November. New started measurements are discussed in chapter six.

4.1 Planning

All metrics, especially when they aim at reliability, should have reference points. That is why planning is so important. This paragraph makes the connection between planning and progression in every day practice.

4.1.1 Planning history

In the summer of 2006 a planning software package called Trimergo was implemented at Damen. Since then for all the projects plans are made consisting of processes that have to be performed and deadlines, called milestones. Now, in 2008, the planning comes to be more common practice at Damen. At first, project managers did not see the added value of extensive plans. This was partly caused by start-up problems of Trimergo and partly by the fact that when project management changed the planning, they did not update the plans in Trimergo.

It cannot be denied that planning was already used at Damen before the implementation of Trimergo, however these plans were not transparent, not performed on a standardized template and not formally communicated. The rapid growth of the organization combined with a need for professionalizing and improving efficiency leaded to the purchase of Trimergo.

4.1.2 Resistance

Two years after the acquisition of Trimergo there is still a lot of resistance against planning. Resistance to usage of the planning software has several sources. One of these sources was easily identified at a presentation\(^\text{13}\) of the new Trimergo version that was held for employees of project management, Work Preparation, Purchase and Engineering. What should have been an instruction session ended up in a plenary discussion, mostly fired up by the Purchasing Director, Cees van Dijk. It seemed that there still exists much uncertainty at the employees that are supposed to work with the program. The first uncertainty that was expressed by one of the project managers is about whether Trimergo will be used in the future or that the program will be replaced within a short time. Employees worry that they will have to learn Trimergo and that once they have mastered the program it will be replaced with another program.

Another repeatedly made remark during the same instruction session was that project managers will be planning the whole day when they follow the planning

\(^{\text{13}}\) This presentation took place at Wednesday November 5, 2008.
A number of the project managers do not see planning as one of their tasks. Although they are manager over their projects and would be helped by up to date plans, they resist to the responsibility. It is important to realize that in order to let planning be successful project managers should participate. Project managers have a lot of obstruction possibilities. To ease the planning efforts of the project managers the updating will be done by the planning employees and the project managers only have to indicate if the plans are still up to date.

A second benefit of this approach in which the planning employees will handle proactively is that project managers rights to change the plans on parts that they cannot influence, like the commit date of the suppliers of long lead items, will be limited. This reduces the resistance of the Purchase employees and probably the resistance of Logistics employees and Engineering employees as well, because they can no longer be blamed for faults in the plans that were artificially made by others to shift the blame. The approach in which the planning employees are the only employees that have unlimited rights to change plans has the advantage that other departments no longer block the solution, but tend to cooperate. A slight disadvantage is that the planning employees have to handle considerable more work and that costs can go up by it. Expectations are that plans will be kept up to date from now on and that performance measurement will be enabled by it.

4.1.3 Planning content

The Logistics Manager has defined several purposes that must be obtained by all plans. On corporate level five things must be insightful at all times (Veldhuizen, 2008c):

- Capacity Engineering
- Status of main components
- Delivery moments to the yards
- Major contract and production milestones
- Effort Damen Field Services and release journeys (journeys to deliver the ship to the customer once it is finished)

The level of detail in the planning is based on the complexity of the ship. If the project is a complex ship to build it will be useful to have a detailed planning while a small ship that is produced in series will not need a detailed planning. The main line of the planning will always be the same. With the use of a work breakdown structure detail can be added.

Four departments are clearly part of the planning (as can be seen in appendix D): Engineering, Purchase, Logistics, and Production. For each department there are lines in the planning referring to either different phases in the building of the ship or to main components that are needed.

Purchase has four elements in the planning under the heading of “Strategic Purchase”: engines, thrusters, propeller, and gear box with the supplier of these materials in brackets behind it. For these four items two moments must be specified: required in production and confirmed by supplier.

4.1.4 Use of planning

When planning is used according to the latest set processes in which the operational work is done by the planning employees, planning has a valid chance to become a success. Only when the resistance of departments and people is turned into cooperation planning can become a success. That is why it is important to design solutions in which the hesitations of others are respected and are taken care for. When looking at the descriptions in the first chapter and in this chapter it might seem
remarkable that planning is still such an issue and has not yet resulted in many benefits. The only way in which planning is used to keep track of performance is discussed in the next paragraph.

4.2 Logistical performance

Measurement
The logistical manager currently performs a couple of measures on regular basis:
1. He calculates the percentages of the parts that are picked and packed of a delivery.
2. Further he generates graphs containing the percentages picked versus not picked, of the goods that are already in the warehouse.
3. The goal of these metrics is not to obtain hundred percent, because about two to three percent are not parts, but activities needed to be performed before the parts can be send to a yard, e.g. punching of tires that will hang against the ship. It would be better if such handlings were not on the parts list. When steering is only done on the percentage it might happen that the performance looks well, e.g. around 98%, but those important parts are not yet delivered. When activities and handlings are no longer on the parts list it will be possible to deliver 100% (when all changes are made in a correct manner).

Management
When it seems that parts are late at a yard, the logistical manager looks for causes. The first question is: are the parts delivered by the suppliers? If this is not the case, it should be Purchase that has to take action. It is important at that moment to recognize the difference between delivery-to-request date and delivery-to-commit date as discussed in paragraph 2.6.2. When the parts did already come in, this is communicated with the warehouse by asking the question: “Why aren’t these parts already on their way to the yard?”

It can be seen that in this way the list that generates the percentage of deliveries that are picked combined with the date that the list is print is used as a first analysis and at the same time it is used to steer the logistical organization. It forms an input to improvement of the processes related to the logistical performance.

The conclusion here is that there is already a coupling of performance measurement with performance management; however both are very slight. Measurement can be used far more extensively to enable steering the performance.

Meetings
Since the fall of 2008 a new approach is used by the Logistics Manager. Every two weeks a meeting is held with project managers, the Head Warehouse and possibly other people from Logistics. During this meeting the deliveries to the yards are discussed. It is indicated which deliveries to the yards are behind on schedule and what the reasons are. This meeting can be seen as a combination of performance measurement and performance management because during the meetings an Excel file is used in which is indicated what deliveries already had to be sent while this did not happen. Also a file is kept with the percentage of the goods that are delivered to the warehouse for the shipments to the yard. If this percentage is too low, Warehouse is not able to fill a container or truck for the delivery to the yard.

4.3 Purchase

Measurement
As described in chapter two in theory there are a lot of possibilities to measure supplier performance. Especially the contracts with bigger suppliers offer possibilities
to measure supplier performance because these contracts often contain delivery times. The Director Purchasing of Damen Shipyards Gorinchem has its own surveys to keep track of the performance of the purchase department. He makes list of what percentage of goods was on time and what percentage was late, split across the responsible purchasers. Because it is important in what week a part is delivered, he calculates these scores on a weekly basis.

Management
With these overviews of the Purchase Director it is possible to manage the performance of the suppliers through benchmarking and it is possible to manage the performance of the purchasers through benchmarking. In practice this is actually not done. The reason for this is that so many parts are delivered late, that it is actually considered useless to knock on the door of the suppliers and ask them why they are late. Also there is a lack of confidence in the measuring method. If you cannot be certain of the measures, it is very hard to manage based on those measurements.

4.4 Conclusion on current practice
The central sub question in this chapter is: “what performance measurement on logistics is currently executed at Damen?"
From the beginning of this report is has become clear that Damen has divided its logistical activities across several borders. Different departments all have their own responsibilities and parts of these responsibilities include logistical activities. Engineering is responsible for releasing drawings on time including a certain level of detail; Work Preparation is responsible for designing a delivery scheme so the parts will arrive on time at the yard. Work Preparation is also responsible for selecting the needed materials. Ordering the materials and assuring that they are delivered on time is the responsibility of Purchase. Warehouse has to process in the incoming parts in the right and effective way to assure that the parts go to the right yard and on time. Shipping documents are of crucial importance to assure that customs will not seize the goods. These shipping documents fall under the responsibility of Work Preparation, Expedition and Transport Coordination.

When it is considered that the responsibilities of Logistics is in fact spread out over all these departments and that all these departments have to cooperate with different product groups on top of that, it becomes clear that managing performance of Logistics is a complicated task. In this chapter it became clear however, that performance measurement targeted at Logistics is performed very little. Moreover the performance measurement that is done cannot be considered cross boarding. An attempt has been made with an integral project planning in which all the different departments are responsible for their own little part of the project, supervised by the project manager and triggered by the planning employees.

The Logistics Manager has a few performance measurements that he uses on a regular basis, all focused on the physical distribution. Purchase has measurements to assess supplier performance, but this is focused internally. The managing part of the performance of suppliers is not communicated to other departments; only the responsible employees of Purchase are included. Therefore it can be concluded that more performance measurement can be introduced to get more grip on Logistics. This increase in performance measurement should then be targeted at managing Logistics across the borders of the involved functional departments and product groups.
5 Requirements

This chapter deals with the requirements that have to be set for a logistical performance measurement system designed for Damen. It combines goals with business processes and the theory as described in chapter 2. At the end of this chapter an answer will be given to research sub-question 3: “what requirements on a logistical measurement system can be derived from literature and from within Damen?”

5.1 Input from previous chapters

The previous chapters have given insight in the way the company operates. The first chapter has shown the size of Damen and the parts of the Damen Group that are taken into account in this research. Six product groups came up as important:

- Tug and Workboats (T&W),
- Cargo Vessels (CV),
- Offshore and Transport (O&T),
- Damen Fast Ferries (DFF),
- High Speed Craft (HSC),
- Damen Technical Cooperation (DTC).

From these product groups only the new build ship operations are taken into account in this research, hence, this research aims at the logistics needed to build new ships. Logistics consists of material identification as well as physical distribution. That is why the chain as presented in Figure 5-1 is important when designing a performance measurement system for Logistics of Damen. Several moments in the time line will be used for metrics designed in this chapter. But not only single moments will be used, for some processes duration is important which will also be linked to Figure 5-1.

Paragraph 2.4 discussed the complexity at Damen. Goal of this performance measurement system is to deal with this complexity. For instance, one of the reasons for complexity at Damen is the customer order decoupling point which can change between ETO, MTO and MTS. Internally agreements are made to see the production system as completely ETO\(^{14}\), which is why the performance measurement system will not need to incorporate inventories, even though paragraph 3.2 indicated that there are some parts that are kept in stock. The reason that this is left out is that the value these parts represent is almost negligible on the total costs of the parts needed for a ship. That is why keeping higher stocks is no problem; big wins can be made at other places in the supply chain.

Paragraph 2.6.1 described several perspectives that can be included in a performance measurement system from which the innovation and learning perspective is seen as the most important for Damen. An innovation and learning perspective implies that improvements have to be made based on the performance and that it is thus important to compare performance throughout the time and perhaps between entities. At least it is important to keep track records of the scores on the metrics in this chapter.

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\(^{14}\) ETO is used by the steering group for the new ERP program.
As already mentioned above, chapter three described the purchase process and identified possibilities for the performance measurement system. It is important to incorporate the findings done in chapter three in the metrics designed in this chapter. Finally the findings in chapter four are used as part of the performance measurement system that already exists, as well as aspects that can be included or used as boundary setting.

The following formula (formula 1) is the general formula for calculating the standard deviation of a sample. Whenever in this chapter average is used, the standard deviation should be calculated as well to know the spread in the sample (as indicated by Soepenberg et al. (2008)).

\[
\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (X_i - \bar{X})^2}
\]

**Formula (1)**

- \(\sigma\): standard deviation
- \(n\): sample size
- \(X_i\): value of x for the observation of i
- \(\bar{X}\): arithmetic mean of values \(X_i\)
A couple of requirements have to be set to generate reliable measurements:

- planning should be regular updated;
- it should be possible to see the track record of changes to the planning;
- it should contain all the important milestones as can be seen in Figure 5-1;
- updated planning should be communicated to all parties involved;
- planning should be accessible on all locations that matter.

\[ \text{Figure 5-2 Delivery reliability. Source: author} \]

### 5.2 Incentives

Setting the right incentives is crucial to the usability of a performance measurement system as soon as it is used for managing the performance. Numbers must be seen in their context, otherwise perverse effects can occur. An example can be given with a reference to Figure 5-2. When delivery reliability to a yard is discussed, DTC must be valued in a different way than the other product groups. Sometimes DTC containers are not yet sent to the yard because the customer has not paid yet for the parts. Hence, all the other product groups sell complete ships while DTC sells packages with which a customer is able to build its own ship. Delivery reliability of DTC can therefore be lower caused by late payments.

It is important that the incentives build into the performance measurement system will not stimulate local optimums, but optimums on a corporate level. In the modern supply chain perspective the corporate level is also a level too low to reach an optimum as the optimum should be reached at the level of the whole supply chain. However as described earlier in this report many suppliers of parts are too small and have not yet developed into parties with which intense relationships can be kept including sharing profits and losses. Performance measurement will at least lead to transparency and incentives will follow as a consequence. These incentives will thus have to be designed with the performance measurement system to prevent perverse effects. Setting the right incentive structure in combination with the logistical performance measurement system will enable streamlining the logistics throughout Damen.

### 5.3 Planning

Already two parts of this report were dedicated to planning at Damen. Paragraph 1.4 and paragraph 4.1 both indicated how planning is done, how it should be done and which problems occur with improving the planning process. Although planning is not totally reliable because earlier plans were not updated and now still not everybody sees the benefits of it, plans should be used for reference points in the performance measurement system. The first important moment in the time line is the moment Engineering is done and handles over the drawings to Work Preparation (Figure 5-1). A couple of requirements have to be set to generate reliable measurements:
Although it is important that planning is done according to the new format described in paragraph 4.1, measuring the releasing of drawings as done in formula 2 can also trigger the cooperation of the employees responsible for their own parts. When for instance the measurement shows that Engineering is releasing drawings too late, they can indicate that planning is not up to date which is their own responsibility.

\[
\text{Drawing delivery reliability: } \Delta d = \frac{\sum_{i=1}^{n}(d_{1i} - d_{2i})}{n}
\]

### Formula (2)

- **\( \Delta d \)**: average days between planned release of drawings and actual release of drawings
- **\( d_{1i} \)**: date of actual release for drawing \( i \)
- **\( d_{2i} \)**: date of planned release for drawing \( i \)
- **\( n \)**: number of drawings

#### 5.4 Long lead items

Figure 5-1 shows that apart from regular products that are ordered when Work Preparation has finished, there are also products that have to be ordered as soon as the project is started because of the long lead time. The reason for this is that on the one hand the lead time for these parts will extend to years, so sometimes even longer than it takes to construct a ship; on the other hand Purchase will try to anticipate on changes in market prices and will therefore choose other moments to buy specific parts. To give an example: the Director Purchasing anticipated a strong increase in the price of copper, a major raw material needed for the construction of thrusters. Because the Director Purchasing knew which ships would be constructed in the coming years and he knew what engines were planned, he also knew what thrusters were needed based on the engine and the shape of the hull. So before Engineering had finished its work and before the orders of the product directors were actually made, the Director Purchasing started buying a lot of thrusters. The result was that the prices indeed did rise and because the selling price of thrusters is established at the moment of delivery to the yard, the producers waited and lead times went up. It is important that such strategic issues are not seen as negative logistical performance; hence a performance measurement system should be able to deal with these kinds of issues.

The most typical long lead items are: engines (CAT or Mak supplied by Pon Power); thrusters (supplied by Rolls Royce); Propellers; Gear boxes (supplied by Reintjes). Next to these most common long lead items other long lead items are possible, depending on the fluctuation in the market.

#### 5.5 Supplier performance

The performance of a supplier should be measured on a regular basis. A supplier that is not performing can disrupt the processes within Damen. In a business where time is of the essence, suppliers should not only be selected and judged on the basis of the prices they ask, but also on delivery reliability, and quality of products (paragraph 2.6.3).

A typical time sequence of the ordering process is represented by Figure 5-3. Another possibility of a typical sequence would be that the promised delivery date would be earlier than the actual delivery date; hence late deliveries are quite common at the moment. The ideal situation will be when requested delivery date equals actual delivery date and promised delivery date. This will probably be the case with parts that are kept in stock by suppliers, e.g. low cost high volume goods.
It is understandable that delays in deliveries can get problematic; however deliveries that are earlier than promised can disrupt the warehouse process. The warehouse of Damen is based and designed on the cross docking principle. When a supplier would deliver a month in advance these parts should be stored and will take up the storage space that is normally used for cross docking. With cross docking it is important to keep parts as short as possible in inventory.

With this information it can be concluded that it is important that a supplier delivers according to plan. Paragraph 2.6.2 as shown several ways to determine delivery reliability. The deviation between actual delivery and promised delivery should be monitored (see Formula (3), perhaps with the use of statistical process control. Because there are so many suppliers, this should be based on the ABC analysis that determines the most important suppliers. Only the most important suppliers should be monitored closely.

\[
\Delta t = \frac{\sum_{i=1}^{n} |t_{ri} - t_{ai}|}{n}
\]

Supplier delivery reliability: \( \Delta t \)

- \( \Delta t \): the average days deviation between promised delivery date and actual delivery date
- \( t_{ri} \): promised delivery date from purchase order line \( i \)
- \( t_{ai} \): actual delivery date for order line \( i \)
- \( n \): number of order lines

The total lead time of the supplier is the difference between the actual delivery date and the placement order. When the lead time of the supplier declines, Damen gets more flexibility in its process because it can order later on in the project. It is however not needed to measure this, just as the deviation between the requested (RDD) and the promised delivery date (PDD). Although the latter would show the helpfulness of the supplier in some cases, it can also be the case that a requested date is just by far not reachable. Also it is important not to have too many metrics at once. When suppliers and Damen are more used to measuring performance it could be implemented just then instead of direct. It is important to prioritize and with the introduction of measuring performance the priority should be with Formula (3).

Except from on time delivery, other aspects of the delivery are important as well. Chapter three has shown that there are requirements a supplier has to reach; e.g. a delivery must be complete at once, no partly deliveries, all goods have to be marked according to the requirements Damen sets, and parts should be undamaged. Although not all the suppliers are faced with the same requirements on marking (see
Table 3-1), registration should be kept simple and standardized so the employees that receive the goods do not have to look up the requirements set for that specific supplier. The advantage is that when it seems that a supplier does not mark the goods in a needed way, Damen can set new requirements when a new contract is made. Formula (4) shows the metric that should be used to determine the quality the supplier delivers.

\[
\text{Supplier quality: } q = \frac{m}{n} \times 100\%
\]

**Formula (4)**

- \( q \): percentage of order lines containing faults
- \( m \): number of order lines containing faults
- \( n \): total number of order lines

### 5.6 Warehouse time performance

When the performance of the warehouse is taken under the loop, a couple of milestones are important. As the two main streams of parts can be categorized based on the transport mode Figure 5-4 represents the timeline for parts that go to a yard by container (sea transport) and Figure 5-5 represents the timeline for parts that go to a yard in Europe by truck (road transport). The timelines are equal to each other when compared from start to finished picking, from there the difference springs.

![Figure 5-4 Timeline warehouse container parts. Source: author](image)

Ideally the complete timeline as represented by Figure 5-4 and Figure 5-5 should fit in the shortest time period as possible. To manage this however, it is better to have performance measures that are more focused on smaller processes. In that case it will be clearer where disturbances originate and what the impact is/will be.

The first important time interval is between receiving and checking quality. During that period the parts will stand on a floor in the receiving space of the warehouse. To have the highest benefit of the capacity it is important that these parts are on this floor as short as possible, otherwise a queue will originate at the gate with trucks that come to deliver goods. When the quality is checked it is important that the parts are stored immediately in the racks until they will be picked.

The time between finished picking and start loading container is clearly a waste of time. The goods are sealed and are still standing on the picking floor waiting for transport. Often the duration of this will depend on the availability of the staff of Unilash who is responsible for filling and lashing the containers. Formula 5 represents the performance measure that is used to identify the responsiveness of lashers to fill containers. Because the Responsiveness is considered as the number
of days it takes before start loading a container after finishing picking and packing, the goal of the performance measure is to minimize the score, i.e. when \( U \) equals zero, the performance is the highest possible.

\[
U = \frac{\sum_{i=1}^{n} |s_{oi} - f_i|}{n}
\]

Formula (5)

- \( U \): average days between start loading container and finished picking
- \( s_{oi} \): moment of start loading container for container \( i \)
- \( f_i \): moment of finished picking for container \( i \)
- \( n \): number of containers

Not all the differences between \( s_{oi} \) and \( f_i \) can be subscribed to Unilash. It is also possible that Damen has not requested someone of Unilash or that there was no container available. Still because it is a waste of money and resources it is important to monitor.

When parts are transported by trucks to yards in Europe picking still will be done in the same way. However Damen is more dependent on the trucking company (Bosman for Rumanian) because again sealed parts will take floor space and standing on a floor is not value adding. What is said about \( U \) (from formula 5) is also true for \( T \) (from formula 6). When \( T \) equals zero, the performance is at its best.

\[
T = \frac{\sum_{i=1}^{n} |s_{ti} - f_i|}{n}
\]

Formula (6)

- \( T \): average days between start loading truck and finished picking
- \( s_{ti} \): moment of start loading truck \( i \)
- \( f_i \): moment of finished picking for truck \( i \)
- \( n \): number of trucks

Both formulas given above are not meant to use as a repression tool to keep an eye on Unilash and Bosman, but must be seen as a tool to see whether the processes are on track. If it seems that the values are too high or are going up, causes can be investigated. Formulas 5 and 6 are of special importance when processes in the warehouse stagnate because the floor space is littered with packed goods ready to be lashed in containers or loaded on trucks.

With the narrow focus on the small processes it is still needed to have control on the complete throughput time of the warehouse. The time goods are waiting to be loaded
in a container or on a truck does not have a big impact on capital expenditure, but is only important because of the limited space, especially with peaks in the activities. Capital expenditure does play a role when goods are stored longer in the warehouse. Even more important is that when goods are stored twice as long, the capacity of the warehouse goes down by fifty percent. The time from receiving goods till sending goods should be two weeks, with an exception for DTC which takes four weeks (Veldhuizen, 2008). It should be measured if this process is in pace. Formula 7 is the metric for parts destined for DTC projects and formula 8 is the metric for parts for all the other product groups. Both formulas calculate the time order lines spend in the warehouse.

\[
\text{Inventory control DTC: } \Delta \overline{d}_{\text{DTC}} = \frac{\sum_{i=1}^{n} (f_i - r_i)}{n}
\]

\[
\text{Inventory control non-DTC: } \Delta \overline{d}_{\text{ND}} = \frac{\sum_{i=1}^{n} (f_i - r_i)}{n}
\]

5.7 Workload control warehouse

Because the warehouse of Damen in Gorinchem takes a special position in the organization, it is important that it has tailor made performance measures. The whole organization is a funnel with its smallest part at the warehouse. The warehouse can be seen as one major resource shared by all business units of Damen Gorinchem. When there is no suited workload control in the warehouse in place, there is a risk of messing up the complete logistical performance as all deliveries will be late. Therefore workload control of the warehouse must be measured in a logistical performance measurement system, it is just that critical for the whole organization spreading all the product groups. How workload control is influenced can be seen in Figure 5-6. The rectangular shape represents the border of the system. The factors outside the border will be influenced by more elements, however not directly related to the workload in the warehouse. (More information about how the method in Figure 5-6 works can be found in appendix C) The green oval represents the workload which is influence by under and over utilization.

The reason that workload and productivity are so important is that the availability of good trained personnel is a bottleneck for Damen. It is not easy to hire employees that can deal with the complexity of the warehouse of Damen, that actually want to work in a warehouse. Therefore the workload per employee should be high, being able to deal with the large increase of throughput.
It can be seen that the workload per employee directly is influenced by the number needed and the number available. A scarcity of employees leads to more delays of shipments. Therefore it is important to monitor how much can be done by the employees and to recognize that experienced employees will be able to do more than un-experienced ones. Formula 9 monitors how much is done per fte (full time equivalent).

\[
\text{Productivity: } p = \frac{\sum n_p + \sum n_r}{h / 40}
\]

Formula (9)

- \( p \): productivity per fulltime equivalent
- \( n_p \): number of order lines picked
- \( n_r \): number of order lines received
- \( h \): total hours made by the warehouse employees within the timeframe.

### 5.8 Transport time

Because the yards are located all over the world, the transport times to the yards differs for each location. Transport times are influenced by the availability of transport for the long distances, i.e. sea transport or road transport in the case of yards in Europe, influenced by the processes at customs, influenced by the availability of transport from the port/customs to the yard and influenced by the terminals. It is important to have statistical process control (SPC) on these transport times. If SPC
shows that transport times go up, the reasons for this can be investigated and plans can be adapted according to the new situation. In this way it will increase the reliability through increasing the predictability. A good way to apply SPC is to determine for every yard an average transport time and a lower and upper boarder. There should go a signal when one of the limits is crossed. With the combination of a three months moving average it will be possible to seen on forehand when the upper or lower limit will be crossed. Of course crossing the lower limit means less transport time which is considered positive as it reduces the total lead time of the parts, still it should be notified because plans can be adapted according.

5.9 Reliability at yard

Most important is that the yard will have all the parts on time, complete, not broken and with the right documentation. Therefore it is of upmost importance that this performance is measured and that the actual performance is communicated to the right persons. A simple formula can be used to determine whether parts are on time:

\[
\text{Delivery reliability yard: } \frac{1}{n} \sum_{i=1}^{n}(d_{ai} - d_{pi}) = \bar{d}_y
\]

Formula (10)

\[
\bar{d}_y: \quad \text{average delay of parts at yard}
\]

\[
d_{ai}: \quad \text{actual date of arrival parts at yard for order line } i
\]

\[
d_{pi}: \quad \text{planned arrival of parts at yard for order line } i
\]

\[
n: \quad \text{number of order lines}
\]

In this case the n is the number of order lines delivered to a yard for a single ship and i is a single order line. The reason that is chosen for order lines instead of containers is that when the parts of an order line are sent with a different container, the reliability is down according to this formula.

In addition to measure the time parts are delayed, it should also be registered how many items are broken or missing. At the moment some of the yards work with container check reports in which they register per container what is missing or broken and if the transport documents are correct, which is important for customs. When these reports are registered in a database in Gorinchem the performance can be compared between yards and product groups over time.

A difference should be made between the order lines that contain broken parts and order lines that are not in the container but are on the packing list.

\[
\text{Incorrectness: } Br = \frac{b}{n} \times 100\%
\]

Formula (11)

\[
Br: \quad \text{percentage of order lines containing broken parts}
\]

\[
b: \quad \text{number of order lines containing broken parts}
\]

\[
n: \quad \text{number of order lines}
\]

\[
\text{Incompleteness: } Mi = \frac{m}{n} \times 100\%
\]

Formula (12)

\[
Mi: \quad \text{percentage of order lines containing missing parts}
\]

\[
m: \quad \text{number of order lines containing missing parts}
\]

\[
n: \quad \text{number of order lines}
\]
5.10 Air freight

As can be seen in appendix B one of the goals from the policy plan 2008 of Cargo Vessels is to reduce the number of air freights with fifty percent. Such a goal is easy to measure. Compare at the end of the year the total order lines of air freights of the division with the total number of orderliness of air freights the year before and then the year before should be at least twice as high as the current year, corrected for the difference in volume for the two years. Although it is a goal of Cargo Vessels, the number of air freights should be monitored for the other product groups as well. As described earlier air freight requires more handlings than regular freight and the productivity of the employees that have to prepare the air freight will decline. On top of that air freight is very expensive and to reduce costs of logistics it makes sense to reduce the number of air freights. There is however a drawback: the number of air freights can only be lowered when the normal flow of parts is closer to planning. With the next formula it is possible to monitor the share of air freights on the total transport.

\[
\text{Air freight } A_f = \frac{n_a}{n} \times 100\%
\]

Formula \( (13) \)

- \( A_f \): percentage of order lines transported by air freight
- \( n_a \): number of order lines by air freight
- \( n \): total number of order lines that have to be transported to another yard than Gorinchem

It is very important that this formula is not used to rigidly. Air freight is used for a strict reason, to assure that the ship can be delivered on time. It cannot get so far as that a ship is delivered late just to keep the air freight low. This is a typical example of setting right incentives as discussed in paragraph 5.2.

5.11 Conclusion on requirements

This chapter has shown that there are many requirements on a performance measurement system. The goal of this chapter was to answer the question: “what requirements on a logistical measurement system can be derived from literature and from within Damen?” Both these sources were used to design a performance measurement system suited for the logistics of Damen. Most important is that there are several moments in time each having delivery reliability that will ultimately influences the delivery reliability at the yard according to Figure 5-7 and Table 5-1. Apart from the time aspect quality controls are included as well that incorporate the requirements on for instance suppliers as described in chapter three.

The metrics introduced in this chapter clearly connect to the complexities described in paragraph 2.4. The fact that Damen has to work internationally is reflected with transport times. Customs regulations are discussed which make it important to have correct documentation. Nonlinearity is incorporated in this chapter with the focus on long lead items. Furthermore time constraints form the center of gravity in the performance measurement system presented in this chapter. Organizational structure is reflected by the fact that the performance measurement systems must be able to distinguish the scores of the different product groups. Indirect information is not totally resolved with this system; however it is reduced with the feedback from the yards to Gorinchem. Limited understanding is reduced as the performance measurement system can be used for communicating the process and performance to key stakeholders.

The other reasons for complexity at Damen: customer order decoupling point, professionalism, growth, proximity, limited substitutions, and resistance to change.
are not very recognizable used in this chapter. This does not mean that they are
totally neglected, however they do not point out with specific metrics. In chapter two it
became clear that the customer order decoupling point can be make-to-stock, make-
to-order or engineer-to-order. Because engineer-to-order is one of the distinguishing
factors from the automotive sector and is quite common at Damen, this specific
performance measurement system is optimized for that production system and can
parts of the system can thus be used for other engineer-to-order industries as well.
The more hard-line requirements on general performance measurement systems
from chapter two are also incorporated in the performance measurement system
designed in this chapter. The characteristics of paragraph 2.7 are all respected in the
metrics and in the system designed. The framework first presented in paragraph 2.8
is not printed in this chapter, although all the formulas in this chapter are placed in
the framework and can be found in appendix G.

It can be concluded that the analysis performed in chapter three was used to set
requirements on supplier performance. Especially marking is important for the
processes of Warehouse and Work Preparation. Therefore control on marking is
incorporated in the performance measurement system.

The total system designed in this chapter can be seen in the table and figure below.

<table>
<thead>
<tr>
<th>Identification</th>
<th>Paragraph</th>
<th>Description</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.3</td>
<td>Drawing delivery reliability</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>5.5</td>
<td>Supplier delivery reliability</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>5.6</td>
<td>Supplier quality</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>5.6</td>
<td>Responsiveness lashers</td>
<td>5</td>
</tr>
<tr>
<td>D</td>
<td>5.6</td>
<td>Responsiveness trucks</td>
<td>6</td>
</tr>
<tr>
<td>D</td>
<td>5.6</td>
<td>Inventory control DTC</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>5.6</td>
<td>Inventory control non-DTC</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>5.7</td>
<td>Productivity</td>
<td>9</td>
</tr>
<tr>
<td>D</td>
<td>5.8</td>
<td>Transport time</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>5.9</td>
<td>Delivery reliability at yard</td>
<td>10</td>
</tr>
<tr>
<td>D</td>
<td>5.9</td>
<td>Incorrectness</td>
<td>11</td>
</tr>
<tr>
<td>D</td>
<td>5.9</td>
<td>Incompleteness</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>5.10</td>
<td>Air freight</td>
<td>13</td>
</tr>
</tbody>
</table>
Ordering of long lead items by Purchase
Releasing of drawings
Ordering of regular parts by Purchase
Production supplier finished

Lead time long lead items

Engineering
Work preparation
Purchase
Parts in warehouse
Transport

A
B
C
D
E
F

Time

Time at customs

Moment of sale
Engineering done
Ordering parts
Receiving parts
Container loaded on truck
Arrival at customs
Container at yard

Figure 5-7 Timeline including metrics. Source: author
6 Current Performance

The goal of this chapter is to formulate an answer to the following research question: "what is the performance of logistics at Damen based on the requirements as set by question three?"

Reading this research question gives the idea that based on the metrics presented in the previous chapter the performance can be readily determined in a non ambiguous way. However, there is one big hurdle yet to be taken. Data has to be collected and in most cases this data is not readily available. This chapter will aim at metrics of which data is available, or is collected at the moment. When available data is not exactly as proposed in the metrics but comes close to it, this data will be used to indicate the performance. The two areas of which limited data is available include the time parts spend in the warehouse en the performance of suppliers. This chapter will start with the time parts spend in the warehouse. Paragraph 6.2 will discuss the supplier performance. Paragraph 6.3 shows how the metrics can be used in combination with each other. Conclusions on this subject and the answer to the above research question are given in paragraph 6.4.

6.1 Time in warehouse

6.1.1 Method

One of the processes that can be measured relatively easily is the time parts spend in the warehouse (Formula 7 and Formula 8 in chapter 5). These formulas consist of two important moments in time that have to be measured:

- the receiving date of the parts;
- the date that the container is loaded.

Registration of the first date is done in the ERP package of Damen. Goods are registered in Mars as soon as they are delivered. Registration is done on the level of an order line form the purchase order. The moment a container is loaded with the parts is not registered in the ERP package. The latest moment that is registered is the moment a part is picked. Therefore the calculations in this paragraph are done with this moment in time. Although it does not give insight in the total time parts spend in the warehouse it is better than not measuring at all and can be a good starting point as one of the first performance measurements.

Data has been analyzed for the following product groups: Damen Fast Ferries, High Speed Craft, Damen Technical Cooperation, Offshore & Transport, Tug & Workboats. From the new built vessels product groups Cargo Vessels is not analyzed in this section because Cargo Vessels stil uses a different ERP package. Hence, Cargo Vessels still has to be incorporated in the Damen structure because the division is obtained later.

The ICT department has made a query from the ERP package in which two dates have to be entered. These dates form the borders of the dates that will be analyzed. The query than produces a text file with several columns:

- purchase number;
- position number;
- days between receiving and picking;
- picking date;
- receiving date;
- agreed deadline according to the purchase order;
- project number;
• and product group.

Opening the text file with Excel makes it possible to determine the average and standard deviation per week. Therefore it is needed to add an extra column with the week number at every row.

By setting an interval it is possible to determine how long parts were in the warehouse before they were picked. For every week an average time is determined of how long parts were laying in the warehouse, as well as the standard deviation per sample. Selecting the query on picking date is necessary to select only parts that are already picked. A major disadvantage of this approach is that this query only looks back. Looking back can be used for improvement processes, but is less suited for active steering. For active steering another query is made that delivers the same columns, only with the selection criterion on the receiving date. When selecting with this query all order lines from two weeks ago until now, it is possible to see what should have been picked, but is in fact still lying on the shelves.

### 6.1.2 Results

The graph below shows the results on the average days products were in the warehouse until they were picked for all the product groups combined.

![Average days in warehouse Total](image)

**Figure 6-1 Time goods spend in the warehouse: Source: author**

For every product group a separate graph was constructed because DTC has a different goal than the other product groups as described before. These graphs can be found with tables containing averages per week, number of order lines and the standard deviation per week, in appendix I.

When the average days for the entire product groups combined are reviewed it can be seen that the top is located at more than 78 days on average of the goods picked in week 29. This means that the goods picked in week 29 were delivered on average in week 18. When it is considered that goods are supposed to be only two weeks in the warehouse for road transport and four weeks for sea transport, the conclusion that performance is lacking is tentative. However, making hard assumptions based on these figures alone includes a risk. For instance a project can be put on hold. Until the product group determines that the project is started up again, all the goods that
have come in stay in the warehouse until the project manager determines that goods can be picked and sent to the yard. Indeed the peak in week 40 was a result of such a decision. Therefore it is always important to base judgments of peaks not solely on the graph, but support the judgments with complementary analyses.

The fact that the graph shows such a high score in the weeks 27 up to end including week 30 is confirmed by the fact that Warehouse was not able to handle the high demand in that period and the period before. From the graph it can be concluded that Warehouse is now better able to handle the demand as the graph has gone down. Still, the goal set by the Logistics Manager is not obtained. These results were shown to the Logistics Manager as face validation. The trend was recognized and he acknowledged that such a graph is very valuable because it delivers easy to understand information.

In addition to the graph that shows the average days parts spend in the warehouse, Figure 6-2 shows the standard deviation of the same samples. As explained in paragraph 5.1 it is important not only to consider the average, but the spread of the data as well. Figure 6-2 shows the same trend as Figure 6-1 with a peak in the summer and a decline in week 31. However, it can be seen that the graph is going up from there to a peak in week 48. When the values of the two graphs are compared, a noticeable fact is that the standard deviation is larger than the average indicating a very diverse data set. Ideally the standard deviation should be close to zero.

![Standard deviation of days in warehouse Total](image)

**Figure 6-2 Standard deviation of time goods spend in the warehouse. Source: author**

It can be explained that the standard deviation is larger than the mean of the sample. When the distribution of a sample would be the normal distribution, clearly the mean would be much bigger than the mean. This is natural to the normal distribution and is used to produce confidence intervals. With a normal distribution 95% of the data falls in between the borders of the mean minus twice the standard deviation and the mean plus twice the standard deviation. However, the time order lines spend in the warehouse does not have a normal distribution. There is a peak of order lines that are very short in the warehouse and every week shows a long tail. After the peak there are still many order lines that are around 200 days in the warehouse before being picked. This causes a small peak at the end of the line and has the effect that the standard deviation is thus larger than the mean.
6.2 Incoming parts

In November of 2008 a project was started registering all the orders that are received on a daily basis. Appendix H shows the forms that were used. The information written down for all goods received was triggered by this research, more specifically the descriptions in chapter three and Formula (4. Because only two weeks of recording has been finished, the outcome is not usable for performance management at the moment. It is better to manage the performance based on larger samples because it will give more reliable results. Another reason for longer measurements before using it to manage the performance is that the employees need time to adapt to the recording of the performance. Only when the employees are used to the forms the information on the forms will be reliable.

Although the sample is too small to give a reliable view on the performance of single suppliers, it can be used as a first insight for an overall picture. Also it shows the format and will show the benefits as a form of validation of the metrics.

6.2.1 Method quality

The above figure shows the handlings that are performed at the receiving part of the warehouse in a simplified form. The first question that is asked is whether it is possible to print a receiving paper. When a receiving paper is printed the order lines that are received have to be selected. Therefore it is possible to determine if the delivered order is complete or the delivery only takes part of an order, which is seen as unwanted. Every order is written down that has at least one question answered with no.

When the receiving paper is printed another form is taken to check the goods. For every order is noted:
- how many order lines are delivered,
- if it is complete,
- if goods are marked,
- if order numbers are combined on a pallet (which should not be the case in order to decrease handlings in the warehouse),
• if the order number is on the packing list,
• whether the packing list is clear,
• if the Excel list is included (only applicable to sets),
• if the packaging is correct,
• if it is a complete delivery or a split order.

Every day the lists filled in by the employees are collected and processed in Excel. It is then determined on a weekly basis which suppliers make the most mistakes and what the average performance is. Managing of this performance will take place from February as then the sample size will be large enough to have reliable results. Registration will be done until summer 2009 at least and might even then be lengthened.

The decision to prolong the registration must be carefully made. Registration cannot be a goal on itself, because it would then only increase bureaucracy. However, at the moment it is unclear if improvements in the performance of suppliers can be seen in the summer. When Purchase is confronted with the measurements in February, first discussions with suppliers will probably be held in March. Considering the fact that there are over 600 suppliers that deliver each year, it can be expected that only a few suppliers will show improvements. To assure the highest benefits it is important to select the suppliers that turn up most frequently on the lists as underperforming. When improvements are made new suppliers will be at the top of the list, indicating that the improvement processes are working and registration thus have to be prolonged.

6.2.2 Results quality

With the information acquired several reports and graphs can be made. The first graph that is made is a graph that shows the percentage of orders from which the receiving paper could be printed (Figure 6-4). Printing the receiving paper indicates that it is clear for which project the goods are determined and it is clear which order it is. The second graph (Figure 6-5) of shows the percentage of correct delivered orders, based on the forms for inspection (appendix H). Normally both graphs will have week numbers on the horizontal axis; however because of the short period of registration as an example the score per day is represented. For the worst scoring suppliers pie diagrams are made showing their scores per category. All the faults of a supplier are added up and then the percentages per category per supplier are calculated (Figure 6-6). In this example the packaging was the biggest problem of this supplier. Assessing the results on the quality of suppliers is not possible at the moment, at least not on the level of single suppliers. Also the method might still change as it is still a testing phase. For instance the Logistics Manager might decide to apply weights to the different criteria. Based on the experiences in the warehouse it might be included that incorrect packaging leads to fewer problems than having different orders combined. This very brief example shows the importance of evaluation sessions with the people directly involved and confronted with the consequences.
Figure 6-4 Orders of which receiving paper could be printed. Source: Maria Fernanda Parra Jimenez

Figure 6-5 Percentage of correct orders. Source: Maria Fernanda Parra Jimenez
6.2.3 On time delivery suppliers

With the query and Excel file described in paragraph 6.1.1 it is also possible to determine if orders were delivered on time by the suppliers. For every order the delivery date is subtracted from the date on the purchase order. Again for all the orders in one week (the week in which the orders were picked) an average is calculated. To make a clear distinction between orders that are on time, too late and too early, the data was separated to create these three categories. An item is in this case considered on time when the date of delivery equals the committed date from the purchase order. It must be kept in mind that this is a very rigid approach because a delivery of a day earlier does not lead to big problems. For a first analysis however, it is good to have a clear boundary. Figure 6-7 shows two different lines. The dark blue line represents the average days an order line was delivered late of all the order lines that were delivered late. The light blue line represents the average days order lines were delivered too early for all the order lines delivered too early and picked in the week on the horizontal axis. The third category, orders exactly on time, is not represented in figure 6-6; hence this category will be exactly on the horizontal axis (zero days deviation) for all weeks.

Table 6-1 shows the distribution among the three categories. As can be seen in the last column, more than half of the order lines are delivered late. Because this measurement is performed on the level of order lines, a big order will have a bigger impact on the overall score than a small order. This seems unfair at first glance, but...
when it is taken into account that all the order lines are needed to build a ship, it is justified. Building a ship it is not important what one supplier delivers; it is important that all parts are delivered on time so the progress in the shipbuilding will not stagnate.

Table 6-1 Order lines delivered too early, on time, or too late. Source: author

<table>
<thead>
<tr>
<th>Week</th>
<th>Number of order lines picked</th>
<th>Percentage of order lines delivered too early</th>
<th>Percentage of order lines delivered exactly on time</th>
<th>Percentage of order lines delivered too late</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>1610</td>
<td>45.0%</td>
<td>5.3%</td>
<td>49.6%</td>
</tr>
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<td>28</td>
<td>1593</td>
<td>36.0%</td>
<td>13.6%</td>
<td>50.5%</td>
</tr>
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<td>29</td>
<td>2677</td>
<td>34.6%</td>
<td>10.8%</td>
<td>54.6%</td>
</tr>
<tr>
<td>30</td>
<td>1933</td>
<td>38.4%</td>
<td>4.6%</td>
<td>57.1%</td>
</tr>
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<td>31</td>
<td>1095</td>
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<td>6.5%</td>
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</tr>
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<td>46</td>
<td>1872</td>
<td>40.4%</td>
<td>8.9%</td>
<td>50.7%</td>
</tr>
<tr>
<td>47</td>
<td>2025</td>
<td>46.2%</td>
<td>13.9%</td>
<td>39.9%</td>
</tr>
<tr>
<td>48</td>
<td>2423</td>
<td>44.5%</td>
<td>5.3%</td>
<td>50.2%</td>
</tr>
<tr>
<td>49</td>
<td>2088</td>
<td>37.1%</td>
<td>12.2%</td>
<td>50.7%</td>
</tr>
<tr>
<td>Total</td>
<td>45914</td>
<td>39.1%</td>
<td>8.5%</td>
<td>52.5%</td>
</tr>
</tbody>
</table>

When an order is a few days early, this will not have a big impact on the processes in the warehouse. However when an order is delivered weeks or months earlier than agreed, this will take valuable warehouse space and goes against the principles of just in time delivery. A few days late however will still have a bigger impact than a few days early. That is why both lines are represented in the graph. Making a judgment on the basis of the graph of late deliveries is a bit tricky. At first a strange deviation could be seen in week 49. Taking a closer look at the data set showed that several order lines from the one order had a date from the purchase order in 1980. Of course this is a mistake as orders in 1980 could not be in the ERP package as it did not exist in that time. Therefore all the order lines that were more than 1000 days late were deleted. When Damen uses this graph to assess the performance, it is important that they look for odd values and check whether these values are correct, or whether an administrative mistake was made. Purchase does not have enough confidence in the correctness of the administrative system to use the late deliveries to steer suppliers. Therefore it is important that administrating deliveries is done more meticulous than it is done before. Even though only a few order lines were deleted (about 20 order lines on over 46,000 orders), not excluding them from the analysis will have impact on the results, especially because the averages are calculated for one week. Only when the

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15 Theo de Bot, December 17, 2008.
own information is correct, Damen will be able to improve the performance of its suppliers.

![Standard deviation of difference between promised delivery and actual delivery](image)

**Figure 6-8 Standard deviation of supplier delivery reliability. Source: author**

As already indicated in the beginning of chapter five (paragraph 5.1) it is important to analyze the standard deviation of every sample that results in an average score. Figure 6-8 shows the spread in the deviation between committed delivery date and actual delivery date. Again two lines are represented: one for orders that are delivered too late, and one for orders that are delivered too early. Because of the small definition of orders on time (zero days deviation), the standard deviation of this third category is always zero.

It can be seen that the standard deviation of order lines that are delivered too late is higher than the standard deviation of order lines delivered too early. This is an indication that order lines that are delivered too late will result in bigger problems than order lines that are delivered too early. On top of that there are higher fluctuations in the standard deviation of order lines that are delivered too late than in the order lines that are delivered too early.

Although the sample size is too small to make hard conclusions on the performance of suppliers, the performance of the suppliers can be expected as not optimal based on these analyses. The number of deliveries that do not contain mistakes is very low. Also many deliveries are considered too late or too early.

### 6.3 Combining performance measurements

When more measurements come available performance management will be more precise. Combining different measurements will give a broad picture of the performance of Logistics. The performance measurements in this chapter only give a small view of the total performance. Figure 6-9 shows the part for which the performance is determined in this chapter.

The combination of the different metrics in this chapter leads to the cautious conclusion that the long time parts are laying in the warehouse is partly caused by the fact that more than 50% of deliveries are too late and more than 39% of deliveries are too early. Only when deliveries of suppliers are perfect on time, the goal of warehouse throughput can be achieved. However, a larger sample size and
more analysis will lead to other causes as well which might turn up to have a bigger impact than the delivery of the suppliers.

6.4 Conclusion current performance

The goal of this chapter was to formulate an answer to the following research question: “what is the performance of logistics at Damen based on the requirements as set by question three?”

With the performance measures designed in the previous chapter it is possible to assess part of the performance of Logistics of Damen (indicated by the red oval in figure 6-9). For the other performance measures data was not available. This is partly caused by the fact that data is not collected; on the other part the data is kept, but not usable to calculate the performance because for instance data is overwritten. The last reason is that some data should be available in the systems that are used at Damen; however scripts have to be made to extract the data. The ICT department is faced with limited resources and could not deliver the scripts within time. In the future these implementations can be made when Damen is convinced of the benefits this performance measurement system will give. On top of data that is in essence available, there are also other parts of the measurement system from which there are no sources of data at the moment. Performance at the yard is now only recorded for a few projects and is not stored in a central file. Determining the overall performance on this aspect is not possible until the available data is stored in such a way that comparisons can be made. Data should be arranged in a way it can be accessed centrally.

The measurements that were performed in this chapter show that a lot of the performance can be improved. The quality of incoming goods can be considered poor as only about 20% of the orders are considered appropriate. With this specific measurement it must be kept in mind that the sample is too small at the moment and
that performance management based on these numbers is only worthwhile when the sample size has increased.

The performance of the warehouse can still be increased either. Parts are stored too long in the warehouse before they are picked. While the goal is to have a cross docking principle with two to four weeks for consolidating and picking and packing, the time before picking is at the moment around the forty days. Improvements can be made in this section as well. The performance of this section can be increased by managing the warehouse tighter, but also the input from the product groups should be included. If they decide that parts cannot be send to the yard, the parts will stay in the warehouse longer and will spill resources. However, it must be considered that as stated in chapter five, local optimums should not be aimed at. It can thus be the case that the decision for the delay of the project will have negative impacts on Logistics, but does reduces negative impact on a higher level.

It is important that Damen keeps a critical stand towards the performance measurement system. During the research in this chapter it became clear that the information that is acquired from Mars (the ERP package) is not always reliable. People sometimes fill in dates that are not correct. Also actions are taken by departments to clean up the system which has its reflection on the performance calculated with the performance measurement system. Other data sources must also be carefully checked on the reliability. The reliability of the performance measurement system is only as high as the reliability of its input. Damen should strive for a high quality of input to stay in control of its processes and to enable performance management trough performance measurement.
7 Implementing and using performance measuring

The previous chapters have shown the processes of Damen. It has become clear that Logistics starts at Engineering because there the first material identification is done. After Engineering Work Preparation takes it over and determines the precise planning of shipments to the yard and determines which parts are included in which shipments. They do this based on the agreements made between the yard and the product group, recorded in exhibits. On top of that Work Preparation completes the parts lists. Finally Purchase takes the information from Work Preparation to order the parts at selected suppliers. Parts that have a very long lead time are ordered before Work Preparation has finished.

Once parts are ordered, they are either delivered at the warehouse in Gorinchem, or sent by a supplier to another supplier or to the yard. Coordination of transport modes is done by Transco and Expedition. Warehouse storage and picking, packing and sending is done by Warehouse. The transport is done by external companies.

The process described in chapter one is combined with the theory in chapter two. The descriptions in chapter two about the organization and the tensions (paragraph 2.3.4) that are a logical consequence of the organizational model are very important in this chapter. This chapter deals with implementing performance measurement and performance management. Using performance measurement to manage the performance of Logistics is challenging because Logistics is divided among the departments mentioned above and can be frustrated by the tensions mentioned in paragraph 2.3.4. Without the right support it is not possible to have adequate performance management based on measurements. That is why the following question is central in this chapter:

“How can performance measurement be used to stimulate continuous improvement at all departments influencing the logistics of Damen Shipyards Gorinchem?”

To formulate an adequate answer to this question at the end of the chapter, this chapter is divided in three paragraphs. The first paragraph will discuss the design principles that should prevent perverse effects of performance measurement. Paragraph 7.2 will discuss how performance measurement can be introduced at Damen and the efforts that are already done. Paragraph 7.3 brings hierarchy in the performance measures from chapter five. Paragraph 7.4 shows how the performance measurement system will be used based on the framework presented at the end of chapter two. Finally the research question will be answered in paragraph 7.5.

7.1 Design principles to prevent perverse effects

De Bruijn (2001) has defined three design principles to prevent perverse effects of performance measurement. These three are:

- interaction;
- variety;
- and dynamics.

These three design principles will be explained below in the following sections.

7.1.1 Interaction

Whenever a performance takes places in an environment with interdependence between the manager and the employees that have to create the performance, i.e. the operational core, there should be interaction between the employees that deliver the performance and the manager that judges the performance. This interaction is
needed to determine definitions, means of measurement and what is done with the measurements. The idea behind interaction between the employees that establish the performance and the manager is that there exists trust between them. This trust is important to prevent perverse effects. To create trust interaction can take place in developing the performance measurement system as well as in using the performance measurement system. It should be kept in mind that in paragraph 2.3.4 three tensions were described that occur in the organization. The second tension described there, between the centralizing power of middle management and the decentralizing power of the operating core, can be kept within boundaries by the design principle of interaction.

During the development of the performance measurement system presented in this report different stakeholders were involved. All these stakeholders were able to give their view on how the performance measurement system should be. As described at different places in this report, some took a critical stand and were not willing to believe that the performance is measurable or even should be measured, while others believe in the benefits performance measurement might deliver.

Trust creating through interaction during the usage of the performance measurement system is important as well. Because the performance measurement system is not in use at the moment, at least not in the sense performance is already managed based on the measurements taking place, it is not possible to point out if trust is maintained during usage. However, it is possible to give guidelines how to use the performance measurement system including interaction. The following two sections on variety and dynamics explain more on this topic. The necessity of trust is underpinned by the Head of Warehouse in section 7.2.

### 7.1.2 Variety

Variety means that there is no monopolization of the meaning making rights of the performance (De Bruijn, 2001). Once the performance has been established, interpretation is needed. This interpretation can be done by someone of the technostructure or can be done by the manager. However, when only one person is responsible for interpreting the results of measurements, the interpretation might get really small. Earlier it became clear that when for instance there is a lot of time between finished picking of the goods and loading the container there might be several causes. For instance, the lashers might be underperforming. Another explanation could be that the lashers were not instructed to start loading. Even other explanations that are less obvious might be possible. For these explanations it is necessary that more people with different views are involved in the process of giving meaning to the performance. Otherwise wrong causes might get pointed out. These different explanations are thus the variety in the performance measurement system.

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16 Director Purchasing, Product Director Cargo Vessels, Production Manager Cargo Vessels, Director Engineering, Logistics Manager, Head Engineering of one product group, Head of Warehouse, employees of Warehouse, employees of Work Preparation, employee of Expedition, employee of Transport Coordination, employees of Purchase
Although the argument is made that variety is needed to reach the right interpretation of the performance, there are limitations depending on the usage of the performance measurement system. When the goal of performance measurement is hard performance management, i.e. settlement based on the measured performance, there will not be much room for variety. When a manager wants to settle on the performance (e.g. firing underperforming employees or giving bonuses) there should be little variety (see Figure 7-1). When variety would be large, the settlement would result in heavy discussions undermining the authority of the manager. With judging a little more variety is tolerated because there are fewer sanctions involved. In paragraph 2.6.1 it became clear that this research aims for an innovation and learning perspective. Figure 7-1 shows that with a learning perspective the tolerance for variety can be quite large, only with a goal of transparency more variety is tolerated.

### 7.1.3 Dynamics

The goal of dynamics in performance measurement is to make performance measurement lively within the organization. Two different kinds of dynamics can be distinguished (De Bruijn, 2001).

- Internal dynamics of performance measurement: i.e. when the performance will be optimal, new measurements will not lead to improvements and the learning goal is no longer supported by measuring.
- External dynamics of performance measurement: i.e. when the environment in which performance measurement takes place changes, there might occur a need for new performance measures.

The idea behind dynamics in performance measurement is that performance measurement stays meaningful and effective. When goals are changed or the environment changes, performance measurement should be adapted according to represent the new situation. Only when the organization keeps developing its performance measurement system, it will be able to have performance measurement as an added value.

A risk of dynamics, but also of the two other design principles, is that the performance measurement system will not be stable enough to be able to compare results over time. Although the argument is made above that there should be a certain flexibility to deal with different views, to find the right causes, or to be able to
deal with changing circumstances, there should always be a level of stability. Stability is needed to have performance measurement on a regular basis instead of as a one-time event.

### 7.2 Implementation

This paragraph is divided among three sub paragraphs. The first paragraph is about timing and discusses the motive for this research as a step to what should be done with the results of this research in next steps. Before is explained how roll out (paragraph 7.2.3) could be done a sub paragraph about support and obstruction (paragraph 7.2.2) is presented.

#### 7.2.1 Timing

The timing of the research that resulted in this report is not a coincidence. The Logistics Manager is faced with a fast growing organization, which is a consequence of combining departments and a consequence of the growth that is described in chapter two and which was one of the reasons for complexity at Damen. The Logistics Manager was educated at the Maritime Engineering faculty of the Delft University of Technology. He is faced with limited time and can use supportive tools to manage his departments. Previous experiences with a graduate student that performed research for him made him decide to ask a student to perform a research in performance measurement, in line with the formalization developments of Damen, and to get more grip on the logistical process. Triggered by the outcomes of the research in performance measurement described in this report the Logistics Manager decided to start measurements at parts where data is not readily available. This data is discussed in the previous chapter.

In political decision making the rounds model (Teisman, 1995) is used to describe decision making processes in which different actors participate. These actors have different roles determining their contribution to the decision making. The rounds that can be identified are acknowledged for the fact that a decision is taken at the end of each round. For the introduction of the performance measurement system this model can be used as well.

The first role that is crucial in the rounds model is the initiator, which in this case is fulfilled by the Logistics Manager. An initiator has a certain goal and acts to obtain this goal. To obtain this goal an initiator needs support of so called supporters that have means to establish the goal. Examples of supporters are: Jeroen Ebbelaar who is involved in analyzing and describing processes of Warehouse; Maria Fernanda Parra Jimenez who is responsible for analyzing the results to the current measurements done at the warehouse; and the Head of Warehouse and employees of Warehouse who fill in the forms discussed in the previous chapter and presented in appendix H. Finally the author of this report can be seen as a supporter as well because he attended several meetings regarding the pilot (which is described in paragraph 7.2.3).

Typical stakeholders that are not involved in the first rounds of the decision making process but that are needed in next rounds are employees and directors of Purchase and Engineering. They fulfill the roles of adapters and critics. Adapters generally look for negative consequences of the decision making and critics try to obstruct because they expect negative consequences.

The support of critics can be of crucial importance. For instance, when the supplier performance has to be improved support of Purchase is absolutely necessary. Recent agreements made between the Logistics Manager and Purchase safeguard the support for next rounds. Warehouse is performing a favor for Purchase by for
instance photographing damaged parts and in return Purchase has to support the performance measurement system once results come in. This agreement enables performance management of supplier performance. Earlier in this report it was found that Purchase takes sometimes a critical stand to the internal processes of Damen and is reserved for taking action towards suppliers. The new registration processes in the warehouse are more carefully performed and will be accepted earlier by Purchase. This is an example of interaction to create trust as described in paragraph 7.1.1. When Purchase and Logistics agree on the measured performance of the suppliers (variety: paragraph 7.1.2), it becomes possible to manage the interfaces between Purchase and Logistics. The interface between Engineering and Work Preparation will be manageable when the release date of drawings is measured.

It can be concluded based on the descriptions in this paragraph that the Logistics Manager has taken steps, and still is taking steps, to assure that performance measurement and performance management will be used in the future. By selecting the right stakeholders at the right time, letting these stakeholders participate when they are needed and by making concessions, the timing of this research is used to introduce performance measurement and performance management. A risk will exist whether performance measurement becomes a success as it is not clear yet if support for the project will last and if the project can be scaled up and will then be supported by more stakeholders. However, the performance measurement system is part of the policy plan of Logistics for 2009.

7.2.2 Support versus obstruction

Resistance to measurements

On mid level management the support for performance measurement is fluctuating. Many of the interviewees were excited about the project at first or at least willing to cooperate. When the outlines of the research became clear to the middle managers who were interviewed, some of them stated that measuring is pointless and that the information that is used as an input to the measurement system is not reliable. Others are scared that the measurement system is based on a too simple model. They state that the reality is so complex, the study should be months longer to be able as a researcher to get the whole picture. It is said that there are too many exceptions to the standard processes resulting in a performance that will not give a realistic picture when it is based on the standard processes.

These arguments from the middle managers do generate two questions. First of all, is it possible to measure the real performance? Secondly, are the processes as they are performed complex because they need to be, or could processes be made simpler? The scope of this research is not wide enough to answer the second question, however interesting this is. Still, is it necessary that they believe in the performance measurement system to make it work? The answer is yes for the parts they have influence on it. As became clear early on in this research the performance at the end of the line is influenced by all the steps preceding it. So when the persons that are resistant to the system are early in the process, they will have influence on the measurements at the end. This does however not mean that performance measurement at the departments that are supporting the performance measurement system is senseless. They can still benefit in different ways from the measurement system. On top of that there is a risk that cooperation is promised but that in fact the people are reluctant to confirm to what they agreed on.

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17 Cees van Dijk
18 Cees van Dijk, Bert Nieuwenhuizen, Bram Kouters
19 Cees van Dijk
How to deal with unwillingness becomes clearer in the next section where a pilot is described.

7.2.3 Roll out

Warehouse pilot
First of all, take the Warehouse as an example of a department that is willing to implement a performance measurement system. The Logistics Manager is supporting the system and also the head of the Warehouse is in favor of the system. Finally, the employees of the department are eager to improve the performance of their department so they are willing to cooperate as well. The Warehouse has two possibilities to make use of the performance measurement system. First they can use it to identify sore places and to start improvement routes. Second they can use it to raise an argument against departments that attack the Warehouse on late deliveries of parts. When parts are not delivered on time to the Warehouse, the Warehouse cannot be hold responsible for late deliveries to the yards. The employees of Warehouse expect that a substantial part of late deliveries to the yards are caused by the low quality of input to the warehouse. When they are not able to show what part of the late deliveries to the yards are caused by late deliveries to the warehouse, they cannot make a hard case against project managers and Work Preparation employees. At the moment this last example is starting to show off. During diverse meetings managers see that problems in logistics often lie on the table of project management instead of on the table of Warehouse. When the total performance measurement system will be rolled out, it will become clear where bottlenecks occur, which processes lead to problems or should be alternated.

That lacking performance can be made insightful at the warehouse is proven in the previous chapter. The moment of delivery by suppliers is fluctuating from the agreement in the purchase order. The quality of the deliveries seems to be lacking in several categories, amongst which marking, packing of different projects on one pallet, and information supply. Inside the warehouse goods are stored too long before they are picked.

The performance presented in the previous chapter of this report is presented to the Head of Warehouse and the Logistics Manager. Both were surprised by the outcomes of the measurements and analyses. The outcomes of previous measurements generate support for more measurements as described in chapter five. Still it is important that the measurements that are performed are used for performance management to assure improvements in the performance, hence the innovation and learning perspective of paragraph 2.6.1. If the Logistics Manager will not be able to increase the performance of the suppliers in combination with Purchase, the Head of Warehouse will be less willing to support the performance measurement system which might endanger registration and will end up in even less cooperation of Purchase and will terminate the system.

Further Roll out
When the pilot in the warehouse proves to be a success, other departments might open up for performance measuring because it can help them to work more effectively and efficiently. However, it must be considered that a good pilot in the warehouse is not a guarantee for introduction at other departments. Reluctant managers still can have arguments why performance measuring is suited for the warehouse, but not for their department. They can have arguments, e.g. that the processes at their departments are less standardized, that they have higher educated employees with responsibilities that require flexibility which is hard to capture in a single metric, etcetera. The design principles interaction and variety both are able to deal with these arguments. Using these design principles in an efficient
way stimulates cooperative behavior. Especially variety is important. When the argument is made that responsibilities cannot be captured in a single metric, giving meaning to the outcome of the measurement with variety gives room for explanations aside of the outcome of the single metric.

Some of these arguments may be valid; however it is important to recognize the difference between valid arguments and excuses not to measure. To break their resistance it is better to have a gradual introduction of a measuring process. This gradual introduction has four advantages.

- The most reluctant departments will see the working at the early adapting departments.
- Teething troubles can be deleted from the system before the system is implemented at their departments.
- Managers can be stimulated to participate in a simple way.
- Changes can be made without a strict hierarchy top down decision. They can either cooperate and they will have the opportunity to bring in their own demands and requirements. Otherwise they might be obligated to introduce the system without having a say in it forced by higher management leading to perverse effects in measuring and interpretation.

Either way, the introduction to more departments should have the support of higher management. When there is a threat of higher management mid level management will be more eager to cooperate because they can increase their influence on the end result. In a way it is the working of the third tension described in paragraph 2.3.4.

### 7.3 Hierarchy in the performance measures

When data comes available the general tendency is to get excited and look for new possibilities for analysis and steering which were not considered before. This is exactly the behavior that was shown by the Logistics Manager in combination with the excitement of the author of this report. However, it is important to differentiate between needs-to-haves and nice-to-haves. Therefore in this section a hierarchie is indicated on how to use the performance measurement system.

#### Need-to-haves

To start with the most important ones the need-to-haves are listed here:

- supplier delivery reliability
- supplier quality
- deliver reliability at yard;
- incorrectness;
- and incompleteness.

The complete logistics of Damen discussed in this report aims at getting the right parts on time at the right yard. Therefore it can be found logical that delivery reliability at yard and incorrectness and incompleteness should be seen as a need-to-have. Because Damen is dependent on its suppliers to receive parts in time, this should be introduced from the start as well. Both on time delivery of suppliers and delivery of the right products in such a way that they can be handled according to the system of Damen, should be measured from the start. The quality of suppliers is influenced by the input given to the suppliers. In the performance measurement system presented in chapter five this is acknowledged by the fact that material identification is part of it (e.g. delivery reliability of drawings). The reason that this is not included as a need-to-have is that delivery reliability of drawings requires more tolerance for variety and is thus harder to catch in performance measuring. The tolerance for the delivery reliability and quality of the supplier is much lower and therefore easier to interpret.
As indicated, the delivery reliability at the yard is the most important and variety is hardly tolerated here.

Nice-to-haves
The rest of the metrics presented in chapter five are less important than the three metrics presented above as need-to-haves. These nice-to-haves do not all have the same importance. There can be made three categories based on importance. The most important nice-to-have is the drawing delivery reliability. As indicated above, there should be some tolerance for variety with this metric. However, for a first analysis on the performance of such a crucial moment it will be helpful and it is advised to introduce the measurement as soon as corrupted data can be avoided. At the moment registration is overwritten causing the reliability of the data going down. The problem with it is that it cannot be seen which data is overwritten and which is not, so there is no possibility to have a correcting calculation.

The second category of nice-to-haves contains the following performance measures:
- responsiveness lashers;
- responsiveness trucks;
- inventory control DTC;
- inventory control non-DTC;
- and transport time.

All these performance measures are important to keep control over little pieces of the logistical process. The reason that these measures are less important than the need-to-haves is that when the need-to-haves show a good performance, the most important goal of Logistics is reached. However, from an innovation and learning perspective as identified in paragraph 2.6.1, it can be helpful to monitor in this lower level. Improvements can be identified. Inventory control and transport time can be used as an input to planning. It might be possible to create a more realistic planning when transport time is differentiated according to yards. As soon as transport time goes up, causes should be found. When only delivery reliability at the yard is monitored, an up going transport time will not be noticed as quickly as with a dedicated performance measure. Inventory control can be used to cut costs. If it is found that order lines are lying in the warehouse too long, action can be taken, especially because the performance measurement is easy to perform.

Responsiveness of trucks and lashers will result in an added value when floor space is scarce in peak demands of the warehouse. Not only is there sometimes to less room for new picks, the full floors result in less possibilities to maneuver through the warehouse with forklifts needed to load containers. Since a new lashing company was hired in addition to the one Damen has been using for years, the possibility occurs to benchmark the two companies. With the performance measure on responsiveness, benchmarking will be easier than without the performance measure. With the results of the performance measurement and the benchmark, it will be possible to improve the quality of the service, if needed.

Two performance measures are clearly of the least importance in the total of performance measures presented in this report. These performance measures are productivity and air freight. Productivity is not very important because daily experiences of the Head of Warehouse will already give a good indication whether future developments will be possible with the current workforce. However, as data will be available it might be handy to assess this performance once in a while, e.g. once a month, to create a clear picture. With the design principle of dynamics changes in circumstances (e.g. another working method), can be evaluated. In a shorter time span the productivity might seem to fluctuate caused by the kind of
goods that are handled. At such a moment it is important to have variety in the meaning making of the performance. This variety will have a positive result on the second tension identified in paragraph 2.3.4 and leaves room for the experience of the Warehouse employees.

7.4 Usage

Apart from introducing the performance measurement system it should also be taken into account how the system will be used to manage the performance. This paragraph will start with the framework from chapter two.

![Figure 7-2 Framework of performance measurement and management. Source: author](image)

For all the measures described in chapter five the above framework should be applied which incorporates most of the theory from the second part of chapter two. In appendix G can be seen how the framework is used for the different metrics. As an example one of the metrics will be detailed with this framework in this chapter. The choice is here made for supplier quality because this performance measure is registered at the moment and is one of the high priorities from the previous paragraph.

**Performance measure:**

\[
q = \frac{m}{n} \times 100\%
\]

- \(q\): percentage of order lines containing faults
- \(m\): number of order lines containing faults
- \(n\): total number of order lines

**What needs to be measured?**

- Supplier performance – quality of delivery.

**Who measures?**

- Employee of Warehouse – incoming parts.

**Frequency of measurement?**

- Administering should be done daily with the use of the forms in appendix H and calculating of the metric should be done for every order and administrated per supplier.

**Frequency of review?**

- Monthly should be determined which suppliers are under performing and need the most attention.
Who acts on data?

- When performance is lacking, Logistics should notify the Director Purchasing about it and he (or one of his employees) should act on it seeking contact with the supplier and interacting to clarify the causes of underperformance. Purchase has to agree with the supplier when improvements can be expected. The arrangement between supplier and Purchase has to be feed back to Logistics. The Logistics Manager will have to coordinate the agreements to the employees of incoming goods and the person responsible for registration and analyses.

Goals and norms?

- Not more than two percent of the order lines should be missing. Furthermore the norm is not yet set for the other quality criteria. It is important however to strive for continuous improvement of the worst performing supplier of that moment. Although the sample size is too small as indicated in chapter six, the expectation is that there is much room for improvements. The norm should be evaluated as well. The goal of this performance measure is to minimize q.

All the other metrics are described in a similar way in appendix G. Measurements are taken weekly, monthly or based on the events. Whenever there is a high volume, measurements should have a fixed time interval. With deliveries to a yard it is not practical to have a constant time interval. It is better to register the scores based on each event, including determining the causes of several scores. Review can be done monthly. The review should not aim for individual explanations, but should aim at trends, benchmarking between different yards, and possibilities for improvement.

For all the metrics the frequency of review is set at once a month. The benefit of having all the reviews with one frequency is that it becomes easier to determine a total view on logistics (as already indicated in paragraph 6.3). The metrics were chosen to generate an overview and give insight in the performance of the logistical chain. Reviewing all the metrics at the same time will give insight in bottlenecks.

Where in the timeline things go right en where things go wrong (remember Table 5-1 and Figure 5-7).

When the metrics are compared on who acts on data the most mentioned person is the Logistics Manager (Martijn Veldhuizen). Only for the lower level processes the Logistics Manager does not have to get involved, because the Head of Warehouse can act on the data. Most of the time the Logistics Manager does not act solely on the data, in many cases he needs to involve other departments. For instance for supplier performance it is somebody of Purchase that should have contact with the supplier, although identification is done by the Logistics Manager and he needs to put it on the agenda of Purchase. Giving interpretation to the numbers of the performance measurement system should not be done by one person and excluding further debate. The interpretation should be open to different stakeholders. Interpretation by different stakeholders will prevent monopolization of the numbers (De Bruin, 2002). Still it is important to have one person accounted for interpretation who then is able to consult others for the interpretation to create variety in explanations. In this sense the success of performance management is largely influenced by the ability of the Logistics Manager to involve other departments and to involve the product groups for some specific measures. In chapter two already a fundamental problem with this was identified. The Logistics Manager has no real power to force other departments to cooperate, which makes it a lot harder. On the other hand the other departments should come to realize that they can benefit from it so they should be willing to cooperate.
7.5 Conclusion on using performance measurement

The central question of this chapter is: “how can performance measurement be used to stimulate continuous improvement at all departments influencing the logistics of Damen Shipyards Gorinchem?”

Three design principles are essential to use the performance measurement system in an efficient and effective way. These three are:

- interaction;
- variety;
- and dynamics.

The goal of these three design principles is to prevent perverse effects of performance measurements, an absolute necessity. With interaction trust is created between the different parties involved in performance measurement. Variety is needed to prevent monopolization of meaning making rights. When variety is tolerated different parties will add to the explanations of the performance which is needed because there are always diverse reasons behind the numbers. Dynamics is needed to make the benefits of performance measurement last by keeping it lively and making it flexible for changing circumstances.

Implementing the performance measurement is starting at the moment but will not be easy. The success of implementation will depend on the pilot that is run in the warehouse. Employees of Warehouse believe in the fact that measuring will result in improvements. Only when these improvements will be established, other departments will cooperate. Cooperation of departments will be positively influenced by the three design principles presented above.

For the purpose of the use of the performance measurement system and for the purpose of improvements, hierarchy is added to the performance measures. Five performance measures are classified as need-to-haves:

- Supplier delivery reliability
- Supplier quality
- Deliver reliability at yard
- Incorrectness
- Incompleteness

The other performance measures are classified as nice-to-haves with three levels of importance. To start with the most important nice-to-have:

- Drawing delivery reliability

The second level of nice-to-haves:

- Responsiveness lashers
- Responsiveness trucks
- Inventory control DTC
- Inventory control non-DTC
- Transport time

The least important nice-to-haves are:

- Productivity
- Air freight

Finally, it is important to have clear defined norms and responsibilities. For every performance measure is determined who is responsible for measuring, who are responsible for interpreting the results and who is responsible for action to improve the performance. With clear norms and responsibilities in combination with different
views it will be possible to use the performance measurement system to improve the performance of Damen.
8 Conclusion and Reflection

This chapter will give the conclusions on the research and will answer the central question:

“what improvements can Damen make to get in control of logistics and to upgrade logistical performance?”

The research question will be answered in paragraph 8.1. Reflection on the research is given in paragraph 8.2. The reflection is on the usability for other companies and on the literature used in this research. Recommendations on implementation are given in paragraph 8.3.

8.1 Conclusion

Damen has grown very fast from 2004 until the present. Like most organizations that show heavy growth Damen is trying to formalize, although it still struggles with the formalization. The Logistics Manager is faced with an increase span of control and needs supportive tools to base his decisions on. Logistics is dependent on other departments like Engineering and Purchase. When Logistics wants to improve the performance, it needs to realize that the other departments have to cooperate. International growth has made the logistical processes more complex and experience is becoming insufficient to steer on.

Purchase has all the contact with the suppliers. For Logistics it is very important that order lines are delivered on time in the right condition with the right information. With many important suppliers are no contracts. There are general documents that determine how the orders should be delivered. The problem with this is that not all documents contain the same information while for the receipt of goods at the warehouse this is very important. During interviews with employees and studying documents it occurred that there are more possibilities to steer suppliers on than is realized at Purchase.

At the moment little performance measurement is performed. An important requirement when measuring delivery reliability is the planning. Damen is struggling with the planning process to standardize it over all product groups. The newest planning process seems promising, although it is not yet sure how it will develop. Although many employees see the benefits of a good plan, there is still a lot of resistance. Different departments and different product groups are not always willing to cooperate. However, this cooperation is crucial because logistics is spread out over several departments and all departments have to work for all the product groups.

Delivery reliability at the yard is most important for Damen to assure that ships can be built without delays. Whenever an average is calculated it is important to look at the spread of the data as well. A spread in data can have a disturbing effect on the performance. Five performance measures are designed that are categorized as need-to-haves:

- supplier delivery reliability;
- supplier quality;
- delivery reliability at yard;
- incompleteness;
- and incorrectness.

These five performance measures should be incorporated within a short time frame to improve the performance of Logistics. This does however require strict procedures
of registering and keeping track of data. Only when the data is saved in a consistent format without overwriting it is possible to have reliable measurements.

Apart from the need-to-haves several nice-to-haves are presented in this report. These nice-to-have performance measures do not all have the same importance. Three categories can be distinguished. There is only one performance measure in the most important category of nice-to-haves:

- drawing delivery reliability.

Only when drawings are released by Engineering on time, Work Preparation can complete the parts list in time so Purchase can order the parts keeping in mind the lead time of the supplier and the moment the parts are needed at the yard.

The second category of nice-to-haves contains the performance measures:

- responsiveness lashers;
- responsiveness trucks;
- inventory control DTC;
- inventory control non-DTC;
- and transport time.

These performance measures are of a lower level than the need-to-haves and the most important nice-to-have. They can however be used to steer lower level processes and focus on specific parts of the logistical process in which performance is lacking or where there is a high chance that improvements can be made.

The least important performance measures are:

- productivity;
- and air freight.

Productivity can be useful to monitor once a month and can be used to anticipate on peak demands in the warehouse. Air freight is mostly used as a means to stay flexible in Logistics. When there would be rigid steering on air freight, a local optimum would be created which would not benefit the logistics Damen wide. Still it can be useful to keep track of the amount of air freight that is used because the costs of air freight are very high and unnecessary air freight should be avoided. Figure 8-2 and Table 8-1 shows the positioning of the performance measures in the logistical process.

The goal of the performance measurement system is to enable improvements in logistics. Analyzing the few data that was available it can be concluded that there is room for performance. The time parts spend in the warehouse from receiving to packing is much higher than the norm that was set by the Logistics Manager. The very small sample of supplier quality seems to develop as underperforming. Unfortunately not enough data has become available to make stable judgments. In the coming period this will become clear.

In order to make performance measurement a success within the organization it needs to be clear who is responsible for measuring. This is done by using the framework presented in figure 8-1. Giving meaning to the numbers should not be done by a single person because many explanations of lacking performance can be possible. To manage the interdependency between the departments it is important that different departments can contribute their expertise on the performance. Three design principles are incorporated for this specific goal and to prevent the perverse effects that performance measurement might have:

- interaction;
With the performance measurement system presented in this report Damen is able to improve the performance of Logistics, including the future developments of the business processes. The performance measurement system aims at the most important aspects of the logistical processes and is designed in such a way that it is understandable for all parties involved. All the involved parties were able to put their requirements on the performance measurement system, although not many of them actually did. Skepticism is not unknown within Damen and the performance measurement system has to prove itself to be accepted. This acceptance is crucial to make the system lasting and to make it a benefit in order to improve the performance.

Figure 8-1 Framework performance management. Source: author
Figure 8-2 Metrics in the supply chain. Source: Author

Table 8-1 Explanation letters in figure 8-1. Source: Author

<table>
<thead>
<tr>
<th>Identification</th>
<th>Paragraph</th>
<th>Description</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.3</td>
<td>Drawing delivery reliability</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>5.5</td>
<td>Supplier delivery reliability</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>5.5</td>
<td>Supplier quality</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>5.6</td>
<td>Responsiveness lashers</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>5.6</td>
<td>Responsiveness trucks</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>5.6</td>
<td>Inventory control DTC</td>
<td>7</td>
</tr>
<tr>
<td>G</td>
<td>5.6</td>
<td>Inventory control non-DTC</td>
<td>8</td>
</tr>
<tr>
<td>H</td>
<td>5.7</td>
<td>Productivity</td>
<td>9</td>
</tr>
<tr>
<td>I</td>
<td>5.8</td>
<td>Transport time</td>
<td>10</td>
</tr>
<tr>
<td>J</td>
<td>5.9</td>
<td>Delivery reliability at yard</td>
<td>11</td>
</tr>
<tr>
<td>K</td>
<td>5.9</td>
<td>Incorrectness</td>
<td>12</td>
</tr>
<tr>
<td>L</td>
<td>5.9</td>
<td>Incompleteness</td>
<td>13</td>
</tr>
<tr>
<td>M</td>
<td>5.10</td>
<td>Air freight</td>
<td></td>
</tr>
</tbody>
</table>

8.2 Reflection

Usable for other companies

The solution found in this research is applicable to other companies apart from Damen. The performance measurement system is suitable for engineering companies that have foreign production sites and that design and steer from their main office. Examples of companies that have comparable processes are:

- Heerema Fabrication Group B.V.;
- Stork Fokker Services;
- Huisman-itrec;
• VDL Bus & Coach;
• Stork Thermeq B.V.;
• and Vanderlande Industries.

A delegation of Damen visited these companies in order to orientate for a new ERP package. The similarities are amongst others the customer built projects, foreign production locations and the parts lists that are connected with drawings. These companies could use the performance measurement system presented in this report, although it should perhaps be altered a little to suit their processes. The importance of reliability is evident in all such companies and production industries in which conveyor belts are not used.

Reflection on literature
Although much has been written about performance measurement in academic literature, the focus has not been often on companies that produce large customer specific projects. The theory of Mintzerg (2003) suits the research well to evaluate the structure of the company, especially when formalization is considered. The structure is used as the environment of the performance measurement system in which it has to operate.

The definitions of Neely et al. (2005) are helpful to distinguish the performance measurement system from performance measures and performance measurement. When there would be no clear distinction between these definitions confusion would arise very quickly, especially with non native English speakers.

The much cited article of Kaplan and Norton (1992) was only partly used in this research. The article has had an effect on the perception of performance measurement in the sense that performance measurement should not be totally financial. In that sense the article had a severe impact on this research, albeit that nowadays non-financial performance measurement is quite common. The perspectives that were summarized in the article of Kaplan and Norton (1992) were useful because now the performance measurement system designed in this research has got a clear perspective: the innovation and learning perspective.

The distinction between delivery-to-request date and delivery-to-commit date made by Steward (1995) and Gunasekaran (2001) seems useful. It occurred during this research that in practice the distinction is not strictly made at Damen. Some dates are confirmed and others are not. Because the ERP package does not make a distinction between the two, it is difficult to have a distinction when the delivery reliability of the supplier is assessed. The fact that apart from the average lateness the variance of lateness also should be measured is an added value to this research. It appeared that the variance is so large that it might even have a bigger impact on the performance than the average.

The design principles interaction, variety and dynamics from De Bruijn (2001) proved to be very useful for the way Damen has to use the performance measurement system. The strength of the design principles is also a weakness. When the numbers have to be interpreted by different employees that all have their own expertise, some might conclude that the performance measurement system is thus not needed. This is however a wrong conclusion because it does point out the performance and assures that everybody is talking about the same performance.
8.3 Recommendations

Damen should be critical with its data to make performance measurement a success. Data should be kept in a structured way and when alternations are made, this should be recognizable.

Other departments should support the performance measurement system. The introduction of companywide planning has shown that such projects are hard to make a success at Damen. Many employees are working at Damen for a long time and show resistance to change. The planning process should be tight in order to make it possible to steer on delivery reliability. Just as with planning, performance measuring is done by diverse employees. Even when the measurements are done by a view selected employees, the meaning making should be done by other employees as well. The managers and directors of the departments should stimulate their employees to cooperate with performance measurement.

The measured performance needs to be turned into improvements noticeable for the employees. The employees want to improve their work and are therefore willing to cooperate. When the improvements will not show within a few months after initiation, the support will decline. It must be considered that introducing performance measurement at Damen will require much effort and will take a long time before everyone is adapted to it.
Literature


Veldhuizen, W.M. (2008a), Memo 043 MV, Damen Shipyards Gorinchem.


Veldhuizen, W.M. (2008c), Memo 061MV, Damen Shipyards Gorinchem.


**Policy Plans:**


Beleidsplan HSNC 2008, Damen Shipyards Gorinchem.


Cargo Vessels (CV) Beleidsplan 2008, Gorinchem.


**Internet:**


A. Overview of metrics

This appendix shows an overview of some of the metrics available in literature. Lists are not extensive and can be overlapping.

Table 0-1 Measures captured on a regular basis within the company. Source: Coyle et al. (2003)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Percentage of respondents capturing that measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbound freight cost</td>
<td>87%</td>
</tr>
<tr>
<td>Inventory count accuracy</td>
<td>86%</td>
</tr>
<tr>
<td>Order fill</td>
<td>81%</td>
</tr>
<tr>
<td>Finished goods inventory turns</td>
<td>80%</td>
</tr>
<tr>
<td><strong>On-time delivery</strong></td>
<td>79%</td>
</tr>
<tr>
<td>Customer complaints</td>
<td>77%</td>
</tr>
<tr>
<td>Over/short/damaged</td>
<td>72%</td>
</tr>
<tr>
<td>Out-of-stocks (finished goods)</td>
<td>71%</td>
</tr>
<tr>
<td>Returns and allowances</td>
<td>69%</td>
</tr>
<tr>
<td>Line item fill</td>
<td>69%</td>
</tr>
<tr>
<td>Inbound freight cost</td>
<td>69%</td>
</tr>
<tr>
<td><strong>Back orders</strong></td>
<td>64%</td>
</tr>
<tr>
<td>Inventory obsolescence</td>
<td>63%</td>
</tr>
<tr>
<td>Order cycle time</td>
<td>62%</td>
</tr>
<tr>
<td><strong>Incoming material quality</strong></td>
<td>62%</td>
</tr>
<tr>
<td>Overall customer satisfaction</td>
<td>61%</td>
</tr>
<tr>
<td>Inventory carrying cost</td>
<td>60%</td>
</tr>
<tr>
<td>Days sales outstanding</td>
<td>59%</td>
</tr>
<tr>
<td><strong>Third-party storage cost</strong></td>
<td>59%</td>
</tr>
<tr>
<td>Forecast accuracy</td>
<td>54%</td>
</tr>
<tr>
<td>Logistics costs per unit vs. budget</td>
<td>52%</td>
</tr>
<tr>
<td>Invoice accuracy</td>
<td>52%</td>
</tr>
<tr>
<td><strong>Product units processed per warehouse labor unit</strong></td>
<td>48%</td>
</tr>
<tr>
<td>Labor utilization vs. capacity</td>
<td>47%</td>
</tr>
<tr>
<td>Equipment downtime</td>
<td>46%</td>
</tr>
<tr>
<td>Processing accuracy</td>
<td>45%</td>
</tr>
<tr>
<td>Orders processed per labor unit</td>
<td>43%</td>
</tr>
<tr>
<td>Perfect order fulfillment</td>
<td>40%</td>
</tr>
<tr>
<td>Case fill</td>
<td>39%</td>
</tr>
<tr>
<td>Units processed per time unit</td>
<td>37%</td>
</tr>
<tr>
<td>Cost to serve</td>
<td>37%</td>
</tr>
<tr>
<td>Orders processed per time unit</td>
<td>36%</td>
</tr>
<tr>
<td>Equipment utilization vs. capacity</td>
<td>36%</td>
</tr>
<tr>
<td>Cash-to-cash cycle time</td>
<td>32%</td>
</tr>
<tr>
<td>Inquiry response time</td>
<td>30%</td>
</tr>
<tr>
<td>Product units processed per transportation labor unit</td>
<td>22%</td>
</tr>
</tbody>
</table>
Table 0-2 Performance measures and metrics. Source: Gunasekaran et al. (2001)

<table>
<thead>
<tr>
<th>Level</th>
<th>Performance metrics</th>
<th>Financial</th>
<th>Non-financial</th>
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<tbody>
<tr>
<td>Strategic</td>
<td>Total supply chain cycle time</td>
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</tr>
<tr>
<td></td>
<td>Total cash flow time</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Customer query time</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Level of customer perceived value of product</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Net profit vs. productivity ratio</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Rate of return on investment</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Range of products and services</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Variations against budget</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Order lead time</strong></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Flexibility of service systems to meet particular customer needs</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Buyer-supplier partnership level</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Supplier lead time against industry norm</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Level of supplier’s defect free deliveries</strong></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Delivery lead time</strong></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Delivery performance</strong></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Accuracy of forecasting techniques</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Product development cycle time</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Order entry methods</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Effectiveness of delivery invoice methods</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Purchase order cycle time</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planned process cycle time</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Effectiveness of master production schedule</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Supplier assistance in solving technical problems</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Supplier ability to respond to quality problems</strong></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Supplier cost saving initiatives</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supplier's booking in procedures</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Delivery reliability</strong></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Responsiveness to urgent deliveries</strong></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Effectiveness of distribution planning schedule</td>
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<tr>
<td>Tactical</td>
<td><strong>Cost per operation hour</strong></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Information carrying cost</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Total inventory cost as:</td>
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<td>X</td>
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<tr>
<td></td>
<td>- incoming stock level</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- work-in-progress</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- scrap level</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- finished goods in transit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supplier rejection rate</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Quality of deliver documentation</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Efficiency of purchase order cycle time</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Frequency of delivery</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Driver reliability for performance</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Quality of delivered goods</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Achievement of defect free deliveries</strong></td>
<td></td>
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</tr>
<tr>
<td>Operational</td>
<td><strong>Cost per operation hour</strong></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information carrying cost</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Total inventory cost as:</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>- incoming stock level</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- work-in-progress</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- scrap level</td>
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<td></td>
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<tr>
<td></td>
<td>- finished goods in transit</td>
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<td>Supplier rejection rate</td>
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<tr>
<td></td>
<td>Quality of deliver documentation</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Efficiency of purchase order cycle time</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Frequency of delivery</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Driver reliability for performance</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Quality of delivered goods</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td><strong>Achievement of defect free deliveries</strong></td>
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</tbody>
</table>
Table 0-3 Delivery reliability measures. Source: White (1996)

<table>
<thead>
<tr>
<th>Data source</th>
<th>Data type</th>
<th>Reference</th>
<th>Process orientation</th>
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<tbody>
<tr>
<td>Internal</td>
<td>External</td>
<td>Subjective</td>
<td>Objective</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
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<td>O</td>
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<td>O</td>
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<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Key
- X = Measure falls only in this category
- B = Measure falls in both categories
- O = Measure can be in either category
B. Goal analysis

All the product groups and several departments have their own policy plans for 2008. These policy plans are analyzed to select the goals that are somehow connected to logistics and the logistical performance. The goals of an organization should be connected to performance measurement. The goals are shown in table 0-4.
<table>
<thead>
<tr>
<th>Department</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damen Shipyards Gorinchem</td>
<td>Managing the many orders on hand. Determining the true available and genuine capacity for engineering, purchase, logistics and project management.</td>
</tr>
<tr>
<td>DSCV</td>
<td>Reducing the number of urgent air transport deliveries with 50%. Guarding and improving lead times of parts. No messaging of late deliveries of components in the last two weeks till deadline. Better harmony of the progress between the yard and DSCV. Minimal two weakly update of planning on both sides.</td>
</tr>
<tr>
<td>O&amp;T</td>
<td>Shorter delivery times achieved by:</td>
</tr>
<tr>
<td></td>
<td>- Further developing standard design series (earlier start of engineering and physical production).</td>
</tr>
<tr>
<td></td>
<td>- Further improvement of the organization, concurrent working methods and production layout and efficiency of Galatz.</td>
</tr>
<tr>
<td></td>
<td>- Improved synergy, unified working methods and component standardization over all logistics centers.</td>
</tr>
<tr>
<td></td>
<td>- Improved logistics (synergy material handling/transport) and earlier involvement in the process by Galatz (engineering, equipment procurement).</td>
</tr>
<tr>
<td></td>
<td>Proper support for Trimergo (or other means of overall schedules/supply chain management).</td>
</tr>
<tr>
<td>DS</td>
<td>Improving product-market combinations including the reinforcement of market position, customer satisfaction and optimization of operational management through:</td>
</tr>
<tr>
<td></td>
<td>- efficient logistical and operational processes,</td>
</tr>
<tr>
<td></td>
<td>- good quality and quality control,</td>
</tr>
<tr>
<td></td>
<td>- quick response times,</td>
</tr>
<tr>
<td></td>
<td>- adequate information supply and communication.</td>
</tr>
<tr>
<td></td>
<td>Steering on key performance indicators of customer satisfaction as:</td>
</tr>
<tr>
<td></td>
<td>- response time,</td>
</tr>
<tr>
<td></td>
<td>- information supply,</td>
</tr>
<tr>
<td></td>
<td>- communication,</td>
</tr>
<tr>
<td></td>
<td>- quality,</td>
</tr>
<tr>
<td></td>
<td>- delivery reliability.</td>
</tr>
<tr>
<td>DTC</td>
<td>Completeness of material packages. Correctness of material packages. Focus on agreements with suppliers about delivery times. The warehouse should stay involved in the control of completeness of deliveries.</td>
</tr>
<tr>
<td>T&amp;W</td>
<td>Limiting failure costs.</td>
</tr>
<tr>
<td></td>
<td>Increasing productivity.</td>
</tr>
<tr>
<td></td>
<td>Preventing delayed deliveries.</td>
</tr>
<tr>
<td>HSNC</td>
<td>Delivery time exceeding with maximal 10% of completions.</td>
</tr>
</tbody>
</table>
C. Logistics analysis focused on urgent deliveries

As can be seen in Figure 0-1 there are several factors influencing the number of urgent deliveries of parts to a yard. An urgent delivery is needed when the part is needed in such a short time that regular deliveries cannot fulfill this need, most of the time the reason for this is that the part was not delivered according to planning. The fact that the part was not delivered according to planning can have several causes:

- A supplier might not be able to deliver the part as promised;
- The time in the planning is shorter than the lead time of the supplier;
- There was a delay in the project before the parts could be ordered;
- There can be a delay at customs because of an error in paperwork;
- A part can be left behind in the warehouse or all the parts of a delivery left the warehouse late.

That urgent deliveries increase the number of air transport can be seen in Figure 0-1. Depending on the size of the parts that are needed the air transport can take several forms. If it just a small part, usually DHL will deliver the package to the yard using air transport. If the part is really fast needed and DHL will take too long, it can even be the case that an employee of Gorinchem is flying to the airport in for instance China, where an employee of the yard stands to pick it up and the employee of Gorinchem will fly back immediately. Most often however, there is not so much hurry that a part is needed and therefore it is also quite common to make a suitcase filled with parts that is given to an employee that is visiting the yard anyway.

Also it occurs that the shipments are larger than can be handled by a single employee and that parts are put into boxes suited for air transport. It can be the case that several boxes will be used for one urgent delivery. When considering that one kilogram air transport costs 2.46 EUR it is clear that urgent deliveries will lead to an increase in costs of logistics.

Explanation on the method in Figure 0-1:
The ovals in Figure 0-1 represent the factors that can become more or less. The arrows represent the influence from cause to effect. A plus means that if the cause increases/decreases, the effect will increase/decrease. A minus symbol means that if the cause increases/decreases, the effect will decrease/increase. The two +? symbols represent the fact that the increase in the cause does not necessarily lead to an increase in the effect, but that it can occur. Hence, if a part stays long enough in the warehouse, eventually it will become an urgent delivery. The same goes for the lead time of the supplier. If the lead time keeps going up, eventually the part will be delivered late by the supplier. The ? explains the fact that the moment of delivery of the supplier together with the moment of the delivery to the yard will determine the time a part spends in the warehouse. Finally the legend shows the use of the different colors.
Figure 0-1 Causal diagram focused on urgent deliveries
D. Standard planning

For every project a plan is made. An example of a plan can be seen in figure 0-2. It is possible to have a more detailed planning. When a project is not complex, the standard planning should be enough; when complexity grows, so takes the detail in the planning according to a work breakdown structure (Memo 043 MV).

The numbered items in the planning have all the same structure as 1.0; 2.0 to 7.0 all consist of a line CAL n.0, DIR n.0, and DEL n.0. To keep the picture convenient these submenus are unfolded.

Engineering, Purchase, Logistics and Production all have their own sub plan which is part of the total plan of the project. These departments are all responsible for updating their part of the plan, although in practice it is often not done. Improvements have been made around the planning process, still the end result is not satisfying. Damen keeps on struggling to implement planning as an efficient and effective process.

As can be seen in the plan, the main focus is on the outfitting process, which is the focus in this research as well. In this plan there are seven deliveries planned to the yard. For every project this can differ depending on how much of the items are supplied from Gorinchem, how large the project is and on whether the yard is experienced building Damen ships.

The most important milestones of the project are always part of the plan and indicated with the triangular shapes. For the processes the beams are added which form the start and end date. The quality of the plans is still fluctuating and should be improved to enable steering on it.
Figure 0-2 Standard planning. Source: Damen
E. Classification of goods

For logistical purposes, a few classifications can be made for goods. These classifications are:

Goods that are delivered on demand

**table 0-5 Delivery on demand**

<table>
<thead>
<tr>
<th>System code</th>
<th>Supplier</th>
<th>System</th>
<th>Type of goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>161</td>
<td>International Paint</td>
<td>Paint</td>
<td>Hazardous materials</td>
</tr>
<tr>
<td>410</td>
<td>Centurion</td>
<td>Batteries</td>
<td>Hazardous materials</td>
</tr>
<tr>
<td>570</td>
<td>MarinAssist</td>
<td>Life rafts</td>
<td>Certification goods</td>
</tr>
<tr>
<td>570</td>
<td>De Wolf</td>
<td>Work / MOB boat</td>
<td>Certification goods</td>
</tr>
<tr>
<td>710</td>
<td>Exalto</td>
<td>Chairs</td>
<td>Voluminous goods</td>
</tr>
<tr>
<td>710</td>
<td>Langendijk/</td>
<td>Mattresses / linen</td>
<td>Voluminous goods</td>
</tr>
<tr>
<td></td>
<td>Intersupply</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**table 0-6 Long lead items**

<table>
<thead>
<tr>
<th>System code</th>
<th>Supplier</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>211</td>
<td>Pon Power</td>
<td>Engines</td>
</tr>
<tr>
<td>223</td>
<td>Rolls-Royce</td>
<td>Thrusters</td>
</tr>
<tr>
<td>213</td>
<td></td>
<td>Propellers/CPP</td>
</tr>
<tr>
<td>212</td>
<td>Reintjes</td>
<td>Gear boxes</td>
</tr>
</tbody>
</table>

**table 0-7 System codes**

<table>
<thead>
<tr>
<th>System code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>000</td>
<td>General items</td>
</tr>
<tr>
<td>010</td>
<td>Acquisition (costs)</td>
</tr>
<tr>
<td>020</td>
<td>Spare parts</td>
</tr>
<tr>
<td>030</td>
<td>Classification (costs)</td>
</tr>
<tr>
<td>040</td>
<td>Trials and supervision</td>
</tr>
<tr>
<td>050</td>
<td>Shipment (costs)</td>
</tr>
<tr>
<td>060</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>070</td>
<td>Design aspects</td>
</tr>
<tr>
<td>080</td>
<td>Financing and banking expenses</td>
</tr>
<tr>
<td>090</td>
<td>Rechargeable expenses and additional charges</td>
</tr>
<tr>
<td>100</td>
<td>Shipbuilding (hull and outfitting)</td>
</tr>
<tr>
<td>110</td>
<td>Hull</td>
</tr>
<tr>
<td>120</td>
<td>Superstructure</td>
</tr>
<tr>
<td>130</td>
<td>Hatches, doors, windows, etc.</td>
</tr>
<tr>
<td>140</td>
<td>Stairs, ladders, handrails, platforms, etc.</td>
</tr>
<tr>
<td>150</td>
<td>Additions to ship's construction</td>
</tr>
<tr>
<td>160</td>
<td>Corrosion protection and deck covering (outside)</td>
</tr>
<tr>
<td>170</td>
<td>Remaining items</td>
</tr>
<tr>
<td>200</td>
<td>Machinery</td>
</tr>
<tr>
<td>210</td>
<td>Propulsion system</td>
</tr>
<tr>
<td>220</td>
<td>Steering system</td>
</tr>
<tr>
<td>250</td>
<td>Dredge system</td>
</tr>
<tr>
<td>300</td>
<td>Primary ship systems</td>
</tr>
<tr>
<td>310</td>
<td>Bilge, ballast, deck wash and internal fifi system</td>
</tr>
<tr>
<td>320</td>
<td>Fuel oil system</td>
</tr>
<tr>
<td>Page</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>330</td>
<td>Cooling water system</td>
</tr>
<tr>
<td>340</td>
<td>Fresh and sea water system</td>
</tr>
<tr>
<td>350</td>
<td>Filling, sounding and de-aeration system</td>
</tr>
<tr>
<td>360</td>
<td>Lubrication system</td>
</tr>
<tr>
<td>370</td>
<td>Ventilation, air-conditioning and heating system</td>
</tr>
<tr>
<td>380</td>
<td>Exhaust system</td>
</tr>
<tr>
<td>390</td>
<td>Remaining primary ship system</td>
</tr>
<tr>
<td>400</td>
<td>Electrical system</td>
</tr>
<tr>
<td>410</td>
<td>Power generating system</td>
</tr>
<tr>
<td>420</td>
<td>Cables and wiring</td>
</tr>
<tr>
<td>430</td>
<td>Switch boards</td>
</tr>
<tr>
<td>440</td>
<td>Alarm system</td>
</tr>
<tr>
<td>450</td>
<td>Lighting</td>
</tr>
<tr>
<td>480</td>
<td>Integrated Information and control systems</td>
</tr>
<tr>
<td>490</td>
<td>Remaining items</td>
</tr>
<tr>
<td>500</td>
<td>Deck equipment</td>
</tr>
<tr>
<td>510</td>
<td>Anchor equipment</td>
</tr>
<tr>
<td>520</td>
<td>Mooring system</td>
</tr>
<tr>
<td>530</td>
<td>Fishing gear</td>
</tr>
<tr>
<td>540</td>
<td>Hoisting equipment</td>
</tr>
<tr>
<td>550</td>
<td>Anchor handling, towing and pushing equipment</td>
</tr>
<tr>
<td>560</td>
<td>Diving equipment / system</td>
</tr>
<tr>
<td>570</td>
<td>Life saving / fire protection equipment</td>
</tr>
<tr>
<td>590</td>
<td>Remaining items</td>
</tr>
<tr>
<td>600</td>
<td>Secondary ship systems</td>
</tr>
<tr>
<td>610</td>
<td>Hydraulic system</td>
</tr>
<tr>
<td>620</td>
<td>Compressed air system</td>
</tr>
<tr>
<td>630</td>
<td>Cargo handling system</td>
</tr>
<tr>
<td>640</td>
<td>(Oil) pollution control</td>
</tr>
<tr>
<td>650</td>
<td>External fire fighting and salvage system</td>
</tr>
<tr>
<td>660</td>
<td>Pre-wetting system</td>
</tr>
<tr>
<td>670</td>
<td>Fixed installations for internal fire extinguishing</td>
</tr>
<tr>
<td>680</td>
<td>Cold store and freezing room system</td>
</tr>
<tr>
<td>690</td>
<td>Sea keeping improvement devices</td>
</tr>
<tr>
<td>700</td>
<td>Joinery and arrangement of accommodation</td>
</tr>
<tr>
<td>710</td>
<td>Joinery (general)</td>
</tr>
<tr>
<td>720</td>
<td>Insulation</td>
</tr>
<tr>
<td>730</td>
<td>Arrangement engine room</td>
</tr>
<tr>
<td>740</td>
<td>Arrangement wheelhouse</td>
</tr>
<tr>
<td>750</td>
<td>Arrangement all living quarters</td>
</tr>
<tr>
<td>760</td>
<td>Arrangement store and boatswain equipment</td>
</tr>
<tr>
<td>770</td>
<td>Arrangement additional spaces</td>
</tr>
<tr>
<td>780</td>
<td>Tools</td>
</tr>
<tr>
<td>790</td>
<td>Accommodation passengers</td>
</tr>
<tr>
<td>800</td>
<td>Nautical navigation and communication system</td>
</tr>
<tr>
<td>810</td>
<td>Navigation lighting</td>
</tr>
<tr>
<td>820</td>
<td>Optical signaling and search light system</td>
</tr>
<tr>
<td>830</td>
<td>Acoustical signaling system</td>
</tr>
<tr>
<td>840</td>
<td>Radar system</td>
</tr>
<tr>
<td>850</td>
<td>Direction finding and course keeping system</td>
</tr>
<tr>
<td>870</td>
<td>Sonar, speed log and depth sounding system</td>
</tr>
<tr>
<td>880</td>
<td>Internal and external communication (TV/audio/video)</td>
</tr>
<tr>
<td>890</td>
<td>Meteorological and other measuring and monitoring systems</td>
</tr>
<tr>
<td>900</td>
<td>Special equipment</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>910</td>
<td>Hydrological and oceanographic equipment</td>
</tr>
<tr>
<td>930</td>
<td>Military equipment</td>
</tr>
<tr>
<td>940</td>
<td>Helicopter equipment</td>
</tr>
<tr>
<td>990</td>
<td>Special equipment</td>
</tr>
</tbody>
</table>
F. Purchase process

The official purchase process as defined by the standardization department is shown in figure 0-3. An explanation of the symbols is given in Figure 0-4. The product with number 17 in figure 0-3 contains the abbreviation HKvS which refers to the high quality standard.
chance of succeeding list. The diagram shows that the purchase process can only start after the processes of work preparation and engineering, which raises problems for long lead items. Reclamation is done when a supplier does not deliver on time. The purchaser gets every week a list with announcements of articles that are late. There is no coordination before delivering and because the list with announcements is so long, it is not possible to contact all those suppliers.

Figure 0-4 Legend for figure 0-3

- Decision symbol
- Document symbol
- Product symbol
- Connection symbol
- Activity symbol
1. Testafdeling en functioneel voldoende

2. - Contact met Projectleider.
   - Stap 2 staat standaard leveranciers, artikel code.
   - Product- en relatieswicwoordlijst
   - Inkoopobjectvoetnotes
een

3. Voorbeelden kennis voor zijn:
   - negatieven
   - intensiteit
   - actualle

4. Gebruik hiervoor de DSA
   - overzichtsnota van het
   - standaardplan

5. Check DSA bestand
   - Volgende goed DSA
   - voor handen?

6. Maak gebruik Project
   - component

7. Contact tussen Inkoop
   - en CE

8. Beide partijen
   - akkoord?

9. Meerdere schepstippen
   - ja

10. Meerdere keer per jaar
    - ingekocht?
     ja

11. Vraag DSA aan
     ja

103
G. PMS

- What needs to be measured?
- Who measures?
- Frequency of measurement
- Measuring/calculating
- Logistical performance
- Who acts on the data?
- Actions
- Other data sources
- Data from Mars
- Processes
- Goals/norms
- Management
- Frequency of review
I. Releasing of drawings from Engineering to Work Preparation

Performance measure:

\[ \Delta \bar{d} = \frac{\sum_{i=1}^{n}(d_{i1} - d_{i2})}{n} \]

- \( \Delta \bar{d} \): average days between planned release of drawings and actual release of drawings
- \( d_{i1} \): date of actual release of drawings
- \( d_{i2} \): date of planned release of drawings
- \( n \): number of drawings

What needs to be measured?

- The releasing of drawings.

Who measures?

- Planning employee: Dimos Moschatsis or Ron Lauwers.

Frequency of measurement?

- Weekly or monthly for the current projects.

Frequency of review?

- Monthly.

Who acts on data?

- Logistics Manager (Martijn Veldhuizen) discusses the development of the performance in the meetings with directing staff/ Director Engineering (Bert Nieuwenhuizen). The Director Engineering then has to ensure that deadlines will be kept by either finishing the work on time or by ensuring that plans are made more realistic.

Goals and norms:

- The goals and norms are incorporated in the metric: the average days between planned release and actual release of drawings should be zero or negative.
II. Supplier Performance

Performance measure:

Supplier delivery reliability: $\Delta t = \frac{\sum_{i=1}^{n} |t_{1i} - t_{2i}|}{n}$

$\Delta t$: the average days deviation between promised delivery date and actual delivery date

$t_{1i}$: promised delivery date from purchase order

$t_{2i}$: actual delivery date

$n$: number of order lines

What needs to be measured?

- Supplier performance – on time delivery.

Who measures?

- An employee of Logistics should be pointed out to measure the supplier delivery reliability of all the suppliers that have delivered within that timeframe.

Frequency of measurement?

- Measurements can be done once a month, however it could be helpful to calculate scores per week as this is done for other measures as well.

Frequency of review?

- Once a month should be determined how well each supplier is performing.

Who acts on data?

- When performance is lacking, Logistics Manager should notify Director Purchasing about it and they should act on it seeking contact with the supplier. It is important that the supplier is contacted with knowledge about the quality as well.
Ideally the norm should be zero, however if the average is only a few days, it should not give any problems. More than a week late will give problems. Important is to consider the spread in the deviation.

**Performance measure:**

Supplier quality: \( q = \frac{m}{n} \times 100\% \)

- \( q \): percentage of order lines containing faults
- \( m \): number of order lines containing faults
- \( n \): total number of order lines

**What needs to be measured?**

- Supplier performance – quality of delivery.

**Who measures?**

- Employee of Warehouse – incoming parts.

**Frequency of measurement?**

- Administrating should be done daily with the use of the forms in appendix H and calculating of the metric should be done for every order and administrated per supplier.

**Frequency of review?**

- Monthly should be determined which suppliers are under performing and need the most attention.

**Who acts on data?**

- When performance is lacking, Logistics should notify the Director Purchasing about it and he (or one of his employees) should act on it seeking contact with the supplier and interacting to clarify the causes of underperformance. Purchase has to agree with the supplier when improvements can be expected. The arrangement between supplier and Purchase has to be feed back to Logistics. The Logistics Manager will have to coordinate the agreements to the employees of incoming goods and the person responsible for registration and analyses.

**Goals and norms?**

- Not more than two percent of the order lines should be missing. Furthermore the norm is not yet set for the other quality criteria. It is important however to strive for continuous improvement of the worst performing supplier of that moment. Although the sample size is too small as indicated in chapter six, the expectation is that there is much room for improvements. The norm should be evaluated as well. The goal of this performance measure is to minimize \( q \).
III. Receiving of goods at yard

Performance measures:

**Incorrectness:** \( Br = \frac{b}{n} \times 100\% \)

\( Br \): percentage of order lines containing broken parts
\( b \): number of order lines containing broken parts
\( n \): number of order lines

**Incompleteness:** \( Mi = \frac{m}{n} \times 100\% \)

\( Mi \): percentage of order lines containing missing parts
\( m \): number of order lines containing missing parts
\( n \): number of order lines

What needs to be measured?
- At the yards needs to be measured whether the delivery is complete according to the content lists and whether the parts are not broken.

Who measures?
- (Assistant) Site Manager.

Frequency of measurement?
- Every time a new delivery arrives. The (Assistant) Site Manager then emails the performance to Logistics.

Frequency of review?
- The performance should be reviewed every month by someone of Logistics.

Who acts on data?
- When the performance is lacking either the Logistics Manager (Martijn Veldhuizen) or the Head of Warehouse (Arie Peursem) should act. It should be sorted out what the reason of the low performance is. Depending on the reason the responsible employee should be spoken to. The employees of Work Preparation take a central role because they will be responsible for the documents on which the order lines in the container are registered. As long as these lists are made by
employees of Transport Coordination, these employees should be included. Finally it might be handy to include the employee who picked the goods.

Goals and norms?

- Both metrics should score less than 2%. Incorrectness (Br) and incompleteness (Mi) should be minimized.
IV. Warehouse time

Performance measures:

Responsiveness lashers: \[ U = \frac{\sum_{i=1}^{n} |s_i - f_i|}{n} \]

- **U**: average days between start loading container and finished picking
- **s_i**: moment of start loading container
- **f_i**: moment of finished picking
- **n**: number of activities from Mars (ERP package)

Responsiveness trucks: \[ T = \frac{\sum_{i=1}^{n} |s_i - f_i|}{n} \]

- **T**: average days between start loading truck and finished picking
- **s_i**: moment of start loading truck
- **f_i**: moment of finished picking
- **n**: number of activities from Mars (ERP package)

What needs to be measured?

- The time it takes between picking and packing of the parts and the moment the container will be loaded. This information is not readily available and should be measured and registered on the work floor.

Who measures?

- Registering has to be done by the employees on the work floor of the warehouse. The measurement can be done with adding a list to the book that is used on the floor. An employee of Logistics should be appointed to determine the score per week and to develop control charts of how the performance on these two measures is developing.

Frequency of measurement?

- Measuring should be done daily; weekly the lists should be processed in an Excel worksheet.

Frequency of review?
When the causes of a lacking performance are known, once a month should the performance be evaluated to make appointments to improve the performance.

Who acts on data?

- The Head of Warehouse should discuss the results of the analysis, after the data is interpreted, with the Logistics Manager. Together they can talk to the lashers or the truck company if that is the problem or to the responsible persons if the lacking performance is caused by employees of Damen.

Goals and norms?

- U and T both should be minimized. The goal is achieved when U and T are both less than one.
V. Total warehouse time

Performance measures:

Inventory control DTC: \[ \Delta d_{DTC} = \frac{\sum_{i=1}^{n} (f_i - r_i)}{n} \]

\(\Delta d_{DTC}\): average days between finished loading parts in container and moment of receiving parts

\(f_i\): moment of finished loading container

\(r_i\): moment of receiving parts

\(n\): number of order lines

Inventory control non-DTC: \[ \Delta d_{ND} = \frac{\sum_{i=1}^{n} (f_i - r_i)}{n} \]

\(\Delta d_{ND}\): average days between finished loading parts in container or truck and moment of receiving parts

\(f_i\): moment of finished loading container or truck

\(r_i\): moment of receiving parts

\(n\): number of order lines

What needs to be measured?

- It needs to be measured how much time parts spend on average in the warehouse.

Who measures?

- When the measurement can take place with reliable data from the ERP package it can be done by an employee of Logistics who is also responsible for other performance measures.

Frequency of measurement?

- Once a month the queries should be run and the performance should be determined.

Frequency of review?

- Once a month the performance should be evaluated with the persons responsible. A taskforce could for instance be started with an
employee of Warehouse, and employee of Work Preparation, and a Purchaser.

Who acts on data?
- When the analyses have identified the causes of the time parts spend longer in the warehouse than the norm dictates, this should be reported to the Head of Warehouse and the Logistics Manager. They can together with the taskforce determine what should be done, depending on the causes.

Goals and norms?
- The goal for DTC is set on 4 weeks and the goal for the other product groups is set at 2 weeks.
VI. Workload control Warehouse

**Performance measure:**

Productivity: \[ p = \frac{\sum n_p + \sum n_r}{h / 40} \]

- \( p \): productivity per fulltime equivalent
- \( n_p \): number of order lines picked
- \( n_r \): number of order lines received
- \( h \): total hours made by the warehouse employees within the timeframe.

**What needs to be measured?**
- How much order lines a Warehouse employee (or fulltime equivalent) can process.

**Who measures?**
- Measuring is done by the Head of Warehouse (Arie Peursem).

**Frequency of measurement?**
- Measuring should be done weekly, based on the last four weeks to reach a stable average. The wide span is needed to dampen the effect of weeks in which mostly large items are processed or weeks in which mostly small items are processed which will reflect on ‘p’.

**Frequency of review?**
- Review of capacity should be done monthly to determine the capacity for the coming period (in combination with the planning). When is known how much an employee can do it will be possible to have a more realistic human resource plan.

**Who acts on data?**
- The Head of Warehouse will act on the data.

**Goals and norms?**
- The goal and norm have to be established once it is clearer how much an employee can do. When a different way of working should be introduced in the warehouse, the dynamics in the performance
measure will enable the possibility to evaluate the new method based on the score of the metric.
**VII. Transport time**

**What needs to be measured?**
- The time it takes a shipment from the Warehouse (the moment the order lines leave the warehouse) to the yard (actual delivery).

**Who measures?**
- Measuring can be done by an employee of Transco/Expedition, or Work Preparation.

**Frequency of measurement?**
- Measuring should be done for every shipment. This can be done very easily in an Excel file by one of the employees mentioned above. It is important that registration is done a central file so it is comparable.

**Frequency of review?**
- Monitoring should be done based on destination using statistical process control and should be updated every month.

**Who acts on data?**
- The Logistics Manager should take action when transport times change. He needs to inform the Work Preparation employees that they have to take other transport times into account when designing a plan for deliveries to the yard.

**Goals and norms?**
- Transport time is mostly determined by factors that cannot be completely influenced by Damen, for instance the time it takes at customs. However, transport time that does go up by bad documentation of Damen should not be tolerated. The norm should therefore be the time it takes a shipment at this moment when there are no problems at customs.
VIII. Reliability at yard

Performance measure:

Delivery reliability yard: \[ \Delta \bar{d}_y = \frac{\sum_{i=1}^{n}(d_{ai} - d_{pi})}{n} \]

- \( \Delta \bar{d}_y \): average delay of parts at yard
- \( d_{ai} \): actual date of arrival parts at yard for order line \( i \)
- \( d_{pi} \): planned arrival of parts at yard for order line \( i \)
- \( n \): number of order lines

What needs to be measured?
- The average delay of order lines/parts at the yard

Who measures?
- An (Assistant) Site Manager should be responsible for controlling the containers and for emailing the performance to Logistics. At Logistics one employee should gather the data in a central file to make the performance comparable and to keep track of the development of the performance.

Frequency of measurement?
- Measuring should be done every time a delivery takes place.

Frequency of review?
- Review should be done once a month with the help of control charts. It will then be possible to determine when a delivery is really considered late, as it is hardly possible to plan the arrival of order lines at China with a time window of one day.

Who acts on data?
- The Logistics Manager is responsible for action when it occurs that too many order lines are received late. Depending on the causes several actions can be taken. If it seems that customs is delaying the deliveries because the transport documents would be inadequate, this should be improved. If containers go away too late, Warehouse should be consulted. If the plans are not realistic, Work Preparation
employees have to take this into consideration when they make a new plan.

Goals and norms?

- Shipments should be on time, however for the yards located far away on time is seen as not more than seven days late. Seven days is the slack that is incorporated for the delivery of order lines for these projects.
IX. Air freight

Performance measure:

\[ A_r = \frac{n_a}{n} \times 100\% \]

- **Air freight** \( A_r \): percentage of order lines transported by air freight
- **\( n_a \)**: number of order lines by air freight
- **\( n \)**: total number of order lines

**What needs to be measured?**
- How many of the order lines actually are transported through the air.

**Who measures?**
- The employees who coordinate the air freight should register. An employee of Logistics can then calculate the performance.

**Frequency of measurement?**
- Every shipment through the air should be registered.

**Frequency of review?**
- Monitoring of the development in air freight should be done every month.

**Who acts on data?**
- First the employee who is responsible for the calculations should consult other what the causes are. The performance combined with the causes should be presented to the Logistics Manager. When the Logistics Manager is not satisfied, he can communicate the performance with the Production Managers or the Product Directors. They can than talk to their project managers how to deal with it and need to let Logistics know what they decided.

**Goals and norms?**
- Cargo Vessels determined the norm to cut air freight by 50%. As soon as it is clear how much air freight is actually used and what the reasons for it are it can be determined if this is a realistic goal.
H. Registration forms incoming goods

Ontvangst goederen

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## I. Measurement results

### Average days in Warehouse Report

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