Asset Management in container terminal design

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Abstract

A key issue in container terminal design is achieving high berth productivity, furthermore the customer expects a highly predictable and reliable service. Container terminals are traditionally designed for a certain capacity. However, in practice this initial design capacity is only a part of the picture. The concession for operating a container terminal is usually granted for several decades while the life cycle of the main equipment spans 10-15 years. Creating a strategy which takes into account the complete life cycle (Design-Construct-Use/Maintain-Destruct) will be beneficial for economic viability. Asset Management (AM) can provide a prospective terminal operator with the tools to develop such a strategy.

Of equal importance to creating an AM strategy is to implement it effectively. Employing a people centered approach will greatly improve the chance of a successful implementation. Involving people from all layers of the terminal operators' organization will not only greatly improve the chance of success, but will also increase the quality of the AM strategy. Having a rationale behind the AM related choices allows the terminal operator to adjust focus and predict the consequences of this new focus.

Based on a recent case study we propose a framework based on the PAS 55 standard by the British Standards Institute. The goal of the framework is to allow a prospective terminal operator to efficiently and effectively manage his container terminal. The main targets are creating a basis for Continual Improvement and implementing maintenance management as an integral part of the operational process.

Keywords: Asset Management, PAS55, container terminals

1. Introduction

In the international sea trade the shipping lines traditionally have a powerful position in the supply chain. This means that container terminal operators need to make the wishes of the shipping lines a main factor in designing a container terminal. From literature (Tongzon, 2002) (Magala & Sammons, 2008) and our previous experience three metrics are the most important decision factors for the shipping lines: berth productivity and the predictability and reliability of service.

High berth productivity is traditionally used as the main design criterion. This initial design capacity is indeed a very useful metric. It does overlook one important factor: time. By including the Design-Construct-Use/Maintain-Destruct cycles of all assets into the design the long term viability of any organization with capital intensive assets can improve. This is especially true for a container terminal since it is usually built with lifetime of several decades in mind. The life cycle of the equipment, especially the cranes, is only 10 – 15 years. By including Reliability, Availability, Maintainability and Safety (RAMS) related criteria early on in the design the prospective terminal operator can get a firm handle on the performance of his terminal over its entire lifespan. The maintenance requirements of the equipment, which are also bound to change over time, can have an impact on the criticality of areas of the terminal. If, for example one Ship-to-Shore (STS) crane is used significantly more than another, it will age faster and may need replacement sooner than when only the age of the crane would be taken into account. If this 'older' crane is in the middle of a quay, this will be a major logistical challenge.

An excellent approach for early inclusion of the demands of the customer (berth productivity, reliability and predictability) is Asset Management (AM) as defined by the PAS 55 standard (IAM, 2008). This international standard was defined by the British Standards Institution and the Institute for Asset Management and used as a basis for AM systems around the world. As we have experienced, one of the biggest challenges implementing an AM program is to convince people in all echelons of the organisation. This asks for a tailor made, people oriented approach. This focus on people as well as procedures creates a way to improve the attractiveness of a container terminal for its main customer, the shipping lines.

2. Framework

Any successful AM implementation must consist of two tracks: Furnishing an AM system and shaping the organisation and the mentality of the people to fit this new system. The two tracks ask for a different approach and skillset which are described separately below.

2.1 Furnishing an Asset Management system

The PAS 55 standard prescribes a host of strategies, plans and management components. Below, in figure 1, an overview of the hierarchy is given.

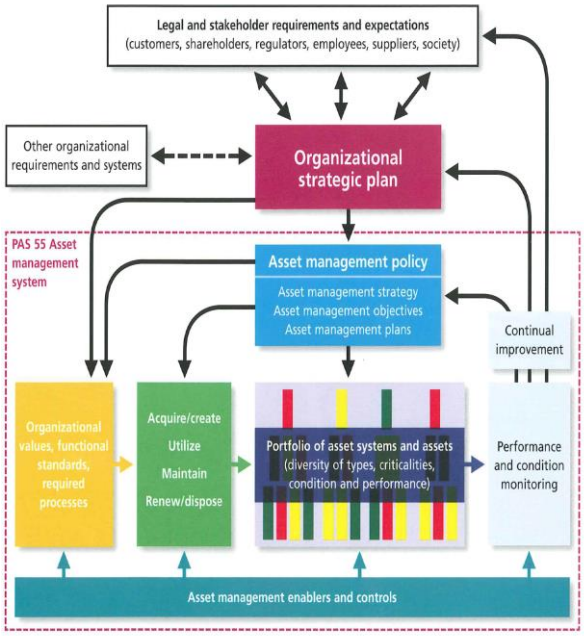

Figure 1. Hierarchy of Asset Management deliverables.

The flow diagram shown in figure 1 visualizes the structured approach of the PAS 55 norm. An example of a strategic goal could be:

> In 2015 the terminal should move 10 million TEU[1] for lowest-in-class cost and without any fatalities.
>
> This goal results in a demand of e.g. a 400 TEU/hr deep sea quay capacity at 80% availability.

This demand can be translated to an AM strategy: e.g.

> We will buy 12 ship-to-shore cranes capable of handling 45 TEU/hr each, which will be out of service a maximum of 24 hrs/month and have a reliability of 99%. Inspection of all active components must be possible in a safe way without an aerial platform.

When such an approached is utilised a so-called asset management "line of sight' is created. This line stretches from the overall business objectives of the organization down to the level of maintenance execution. When the terminal is in the operational phase of its lifetime this ensures that all maintenance and preservation activities that are to be executed on the different equipment are in line with and contribute to the high level organizational objectives; the task description on the work order is a direct result of the goals defined by higher management. The asset management line of sight is schematically illustrated in figure 2.

[1] Twenty foot Equivalent Unit – The standard measurement of production in container handling

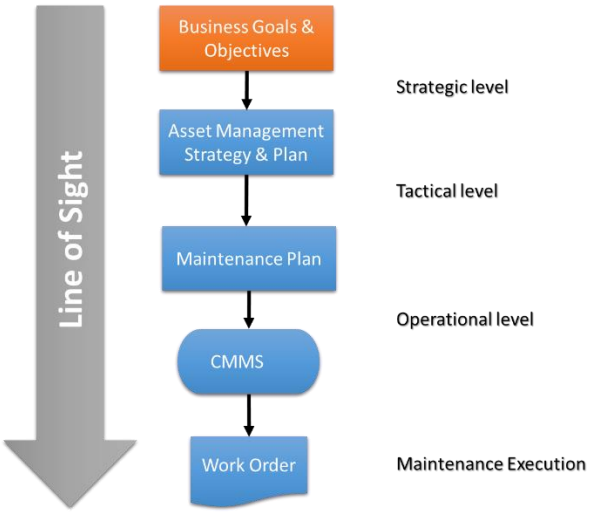

Figure 2. Asset Management line of sight.

Selecting a shortlist of suppliers to aid in defining the AM strategy is often quite useful. In fact it is recommended at this stage to include the supplier into the process. This inclusion, together with good contract management (for example including AM-related deliverables), can ensure a positive working relationship and improve the fit of the product with the (long term) demands. Maintainability is often overlooked in purchase contracts. The supplier can be more than happy to claim high reliability and/or availability, but reaching these figures might require a crane to be shut down for maintenance weekly or even daily. Indirectly the individual equipment maintainability will also have an impact on the terminal as a whole.

After the requirements for the assets have been defined in the AM strategy it becomes necessary to gather technical information from the supplier. This technical information is used as input for the AM plan. In this plan, amongst others, the maintenance strategy is defined. The asset management plan, which the new ISO55000-standard calls SAMP or Strategic Asset Management Plan, is used as the top-level document for all asset management related decisions. Similar to the line of sight principle described above, the documents that follow from the asset management plan are in line with the demands and objectives laid down in this document. The choices and decision regarding technical and economic lifetime decisions and the time horizon are defined in the AM plan. In this case we started after contract formation in setting up the asset management policy, focusing on the operations and maintenance part of the system life.

Based on these decisions the maintenance plans for the terminal equipment can be defined. The supplier documentation and a risk analysis based on Risk Based Maintenance (RBM) or Reliability Centered Maintenance (RCM) form the contents of the maintenance plan.

The Deming circle, also known as a Plan-Do-Check-Act (PDCA) circle and the related concept of continual improvement play an important role in the PAS 55 approach to AM. Figure 3 shows the PDCA circle applied to AM.

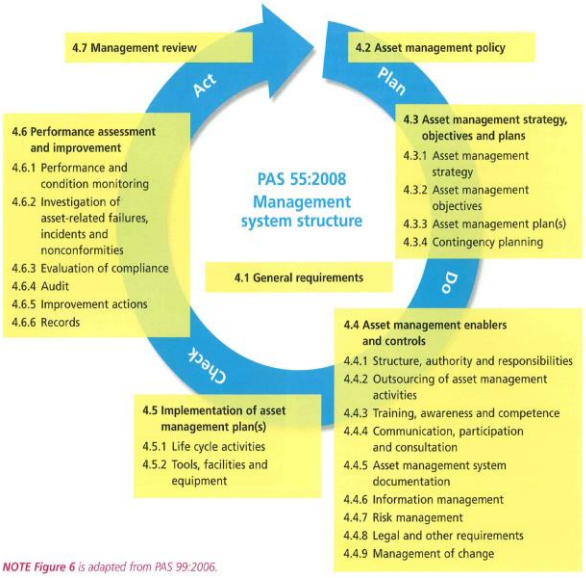

Figure 3. PDCA circle applied to Asset Management.

Through a Continual Improvement program the most pressing issues can be identified and solved via organizational change, maintenance plan adjustment or the modification of assets. It is important that changes are managed via a management of change procedure. By using this rational and recorded approach there is always a firm basis to make decisions and even predict the effects of certain budgetary constraints as may be put down by upper management. The check phase is concerned with measuring performance of both the assets and the organization itself. This performance can be expressed in well-defined Key Performance Indicators (KPIs) and Process Indicators (PIs) and should be constantly monitored and evaluated based on a management system. In this management system a meeting structure can be set up which gives each of the PDCA phases a discrete span of time. The structure of the management system can be of great use in the continual improvement process. Besides these monitoring tools it is of high importance to describe the work flow of the maintenance organization. In this work flow the flow of information, work and goods is described for planned maintenance and breakdowns to ensure efficient and effective execution of the maintenance plan. This includes a clear definition of responsibilities according to the RASCI method.

Traceability is one of the key strengths of the AM-methodology. Maintenance is based on company vision, mission and values; therefore the impact of any decision, be it on budget or otherwise, can be translated and its effects predicted. This means the responsibility for any choice will remain where it is made.

2.2 Adjusting mentality

As said, only theory and computerized systems will bring you nowhere. It is of equal importance that the organization embraces AM. Mens (Mens, 2012) underwrites the importance of leadership and understanding of the psychology of change management. Appointing a Change agent for each main process is a good way to improve the chance of success. If every topic has a face in the organization people are

much more likely to follow the lead. Support from the highest echelons of an organization is also a great influencer; if upper management practices what it preaches and visibly supports the efforts to implement AM, this will inspire others to follow suit.

According to Kotter (Kotter, 2007), another large contributor to the chance of success is by talking to every stakeholder about their personal benefits. For example; an asset manager can use the reliability data and company values-based maintenance plan to show the consequences of budget cuts to the asset owner. Secondly maintenance engineers and service mechanics can greatly benefit from an extensive record of disruptions and breakdowns for proposing modifications or troubleshooting. Also the operational department will benefit from higher predictability of maintenance requirements and more accurate predictions of the asset performance over time.

3. Case study

In a recent case study we were involved in a Greenfield terminal project from the construction phase onwards. This was due to the view of upper management that AM might be a leap forwards for container terminals. As described by Jacobs (Jacobs, 2013), more could have been achieved by employing AM-methods earlier in the project. As also mentioned in the above section, including AM-related deliverables in the tender process for a piece of equipment can go a long way in ensuring a well informed and capable AM department.

Before the start of our project a futuring session was performed. This resulted in a clear vision, mission and set of future goals for the organisation (Crombag, 2012). One of the decisions already made in this phase of the project was the sourcing strategy. The 'cut' was made at tactical level, with roles from department head to planner/work preparation insourced and all preventive maintenance execution outsourced. This creates a clear division between the Asset Management roles of Asset Owner and Asset Manager on one side and the Service Provider on the other.
Figure 3 shows an overview of the main deliverables of our recent project. The graph is organized according to logical flow of the deliverables.

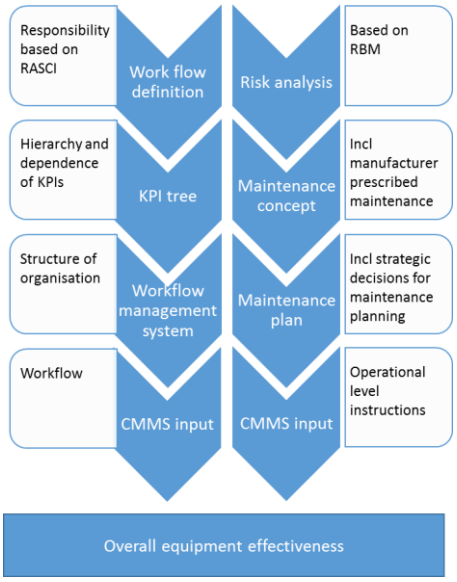

Figure 4. Flow of Asset Management related deliverables for terminal project.

Having a maintenance system and department up and running before 'go live' of the terminal has a great advantage. It allows you to focus on learning from operational and maintenance experience with the terminal equipment and the most important disturbances instead of constantly struggling to keep up.
A good practice of measuring the performance is through the OEE. At the terminal this KPI is used to gain insight into AM department strategic performance. It is calculated by multiplying availability, efficiency and effectiveness. Besides providing insight in the performance of different departments it also sheds light on the exchange in performance between the departments when certain choices are made. This serves to fulfil the Asset Manager role the department has, but at the same time it allows higher management to report terminal performance to shareholders and other external stakeholders, filling in the Asset Owner role. Because of the importance of this metric it is vital that the OEE has an unambiguous definition that is used and supported throughout the organization.

The second part of the results is related to organizational change. In the process of defining maintenance plans and organizational processes the project team has involved people throughout the client's organization. From the managing director (figurehead and decision maker on quantifying company values) to technicians and even the liaisons from equipment suppliers (assessing risk and proposing maintenance tasks based on these risks). One of the most important processes that was defined in advance is the Continual Improvement (CI) process. This is done by instating Plan-Do-Check-Act cycles, visualised in figure 5.

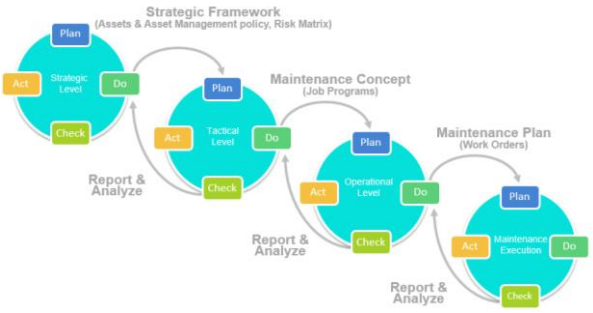

Figure 5. PDCA circles as used at different levels within the Asset Management department.

The CI process provides maintenance engineers and managers with a formal structure (both procedural and organizational) on which to mark their progress. As figure 4 shows, there are multiple cycles, each with a different timeframe and place in the organisation.

Still, some project issues remained. One major delaying factor was the lack of focus of the project managers for the new-built equipment on maintenance and lifecycle management. This can be explained by the fact that usually they will not be the ones using the equipment and both their focus and assignment is on ensuring the equipment is delivered on specifications, budget and schedule.
Secondly, because the case concerned a newly built terminal no historical data for the use and maintenance of the equipment was available. Suppliers rarely have this since they are seldom involved in the usage and servicing of their own equipment. This meant the basis for the maintenance program had to come solely from expert opinion.
Thirdly, because no AM-related deliverables were given a lot of concern in the tendering process, the suppliers did not focus on handing in maintenance manuals and other documentation.

Regardless of these issues, a good result has been achieved. At the start of operational testing and before most employees of the AM department started working, the work flow (including management system) was defined and the maintenance plans were ready to be uploaded into the CMMS (including, where needed, detailed work descriptions).

4. Conclusions

Asset Management can be a key success factor in creating a terminal that satisfies the demands of reliability and predictability at a low costs per move. Applying AM principles as early in the design as possible will yield the best results. Due to the focus on the CI process, the terminal will not only be up to par at the start of an operation, but continue to do so in the future. In the context of PAS 55 style AM the capital intensive assets (within their operational context) are at the centre of attention instead of the organizational structure itself, as is often the case. Maintenance decisions are taken based on company values and risks and function as a part of the integrated AM processes.

In order to effectively implement AM, it is necessary that people throughout the organization (e.g. also outside of the AM department) have embraced the change of work flow and open communication associated with AM. The operational department is particularly important since open communication and mutual understanding between operations and the AM department can improve not only the working atmosphere but also terminal performance due to increased reliability. This reliability is, as mentioned in the beginning of this paper, one of the main drivers for shipping lines to select a terminal for their business.

An important driver for success is appointing change agents for each main step in the AM implementation, especially if these are clearly championed by upper management. It is important to realize that AM is not 'something we are also doing' and cannot be regarded as a separate project or process. It is a way of working and thinking that must be integral to running any company that earns its money with capital intensive assets and certainly one as interconnected as a container terminal. If this realization is not shared throughout the organization making plans and introducing computerized tools will make little to no difference in efficiency and effectiveness.

In the case study, an organization was created with the will to continually improve. It has its processes defined by workflow and management system, both of which can be monitored through a multi-layered set of KPIs. The expected increase in reliability and predictability of service at the terminal, coupled with low cost per move, will be a boon to shipping lines, improving competitive advantage of the terminal for its main customers.

5. Recommendations

Any AM implementation project can stand to learn from change management best practices and keep involvement high and continuous, even though this may seem to impair the efficiency of the project. Every hour spent explaining and convincing in advance is worth ten along the line.

Subsequently, this also holds for the AM deliverables such as a work flow description and maintenance plans. It may seem like time better spent on other aspects of the new terminal project, but all time spent in advance will pay out. Besides this, creating the plans and procedures is the least part. Ensuring cooperation and compliance from everyone in the organization is going to take much more time and effort.

In practice it proves difficult to create awareness of the importance of AM for project employees and suppliers. This should not be a deterrent to increase efforts, because using AM should enable terminal operators to improve business performance over the lifetime of their terminal. In the past the effects of continual improvement have been significant; a 10% decrease in Total Cost of Ownership has been reported in some cases. The inherently time-dependent nature of demand and the state of equipment is included integrally into the AM processes.

Ideally AM principles would be used from the very start of terminal design and building. In practice this is not always feasible. It is important to realize that people usually can only entertain one new notion at a time and taking steps that are too big will only lead to unwanted behaviour and misunderstanding.

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