

# MoorMaster®

Revolutionizing the mooring of vessels for safer and more efficient container terminals.

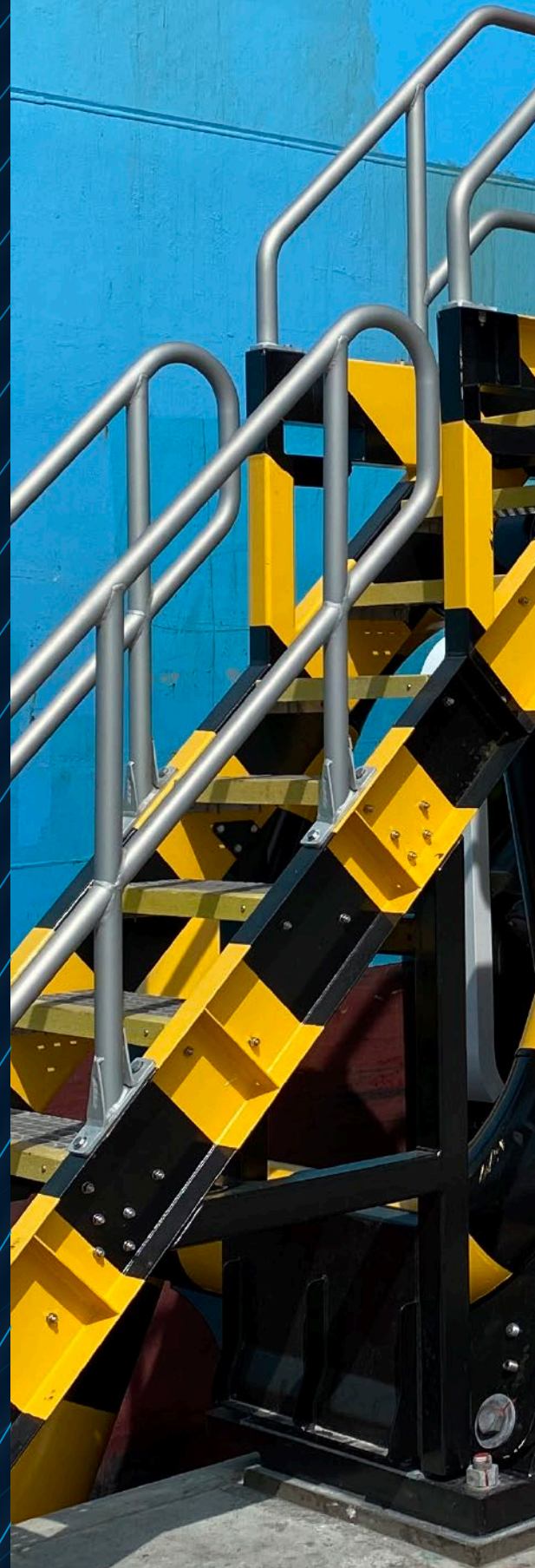


# Executive Summary

Container terminals face growing challenges as global trade expands. With increasing demands for efficiency, safety, and sustainability, traditional mooring methods often fall short. Mooring lines are not only time-consuming but also pose significant safety risks and create inefficiencies that ripple across terminal operations. For example, the lengthy process of manual mooring can result in hours of lost operational time each week, disrupting cargo handling schedules and driving up costs. These challenges ultimately limit throughput, delay vessel schedules, and increase expenses for both terminals and shipping lines.

This white paper discusses **MoorMaster**, an advanced automated mooring system designed to address and overcome these challenges. By automating the mooring process, MoorMaster reduces mooring times to under a minute, eliminates safety risks associated with manual mooring lines, and stabilizes vessels to enhance ship-to-shore crane productivity. An investigative project at a leading container terminal in Morocco, APMT Tanger Med 2, confirmed these benefits related to operational efficiency, focusing on the reduction of mooring times and the improvement of ship-to-shore crane cycle times. MoorMaster delivers these advantages even at a state-of-the-art terminal like APMT Tanger Med 2, showcasing its exceptional capabilities.

The paper explores the key challenges faced by container terminals, compares MoorMaster to traditional mooring methods, presents real-world results from the lighthouse project, and highlights how this technology can benefit stakeholders across the shipping industry. Ultimately, MoorMaster offers a transformative solution that meets the evolving needs of container terminals, shipping lines, and global trade networks.



*"Thanks to MoorMaster, we achieved unprecedented operational efficiency. Mooring times of vessels have reduced by 70% and the stabilization of vessels resulted in a measurable increase in crane productivity, allowing us to better serve shipping lines."*

***Keld Pedersen, Managing Director  
at APM Terminals West Med***



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# The Challenges of Mooring in Modern Container Terminals

*Container terminals operate in demanding environments where efficiency and safety are paramount. However, traditional mooring methods, which rely on mooring lines, present significant operational challenges:*

## Operational Inefficiencies

- **Time-Consuming Processes:**  
Vessel arrival and berthing can take two to four hours<sup>4</sup>, with traditional mooring alone requiring 30-60 minutes to secure or release a vessel. During this time, ships remain idle, consuming fuel and delaying cargo handling schedules.
- **Fuel Wastage and Emissions:**  
Prolonged idling during mooring operations increases fuel consumption and emissions of the vessels and tugboats, adding to operational costs and environmental impact.
- **Vessel Instability:**  
Mooring lines struggle to stabilize vessels against external forces such as wind, long waves, swell waves, and passing ships. This instability slows down container handling rates and reduces crane productivity.
- **Labor Dependency:**  
Manual mooring requires skilled workers, and labor shortages in some regions exacerbate delays and safety risks.

To remain competitive, terminal operators must optimize their infrastructure to accommodate growing vessel sizes, enhance efficiency, and reduce costs. However, these challenges are intensifying as climate change accelerates global weather volatility.

Recent studies show increasing global wind and wave activity. Over the past 30 years, global mean wave heights have risen by approximately 5%, while wind speeds have increased by around 1.5% per decade. In extreme cases, such as the Southern Ocean, wind speeds have surged by 8%, directly influencing wave heights, according to a study from Nature Communications. Additionally, Climate Central's reports that hurricanes have not only become more frequent but also more intense, with wind speeds increasing by 8–11% due to rising ocean temperatures. These worsening conditions directly impact coastal areas, including ports, further destabilizing vessels and hampering crane productivity.

This growing environmental volatility underscores the urgent need for terminals to adopt innovative solutions like MoorMaster, which can mitigate vessel instability, enhance safety, and ensure smooth operations – even in challenging weather conditions.

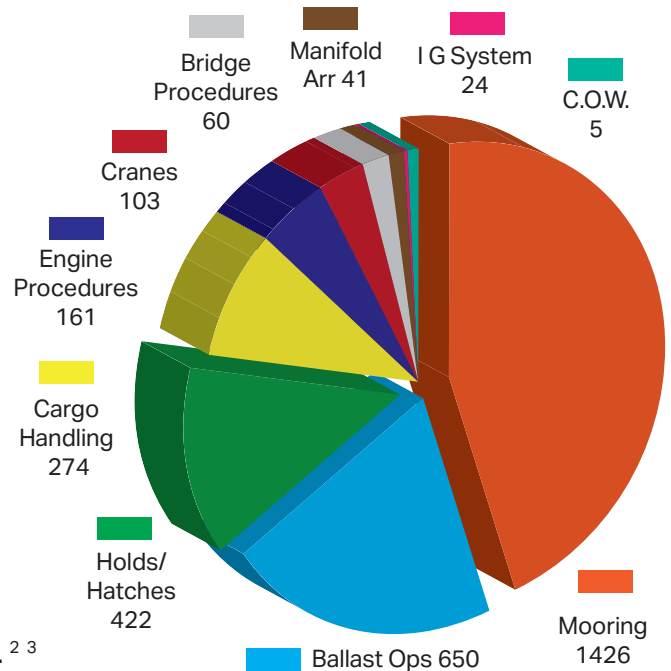
## Safety Risks Associated with Mooring Lines

Mooring lines pose a significant safety hazard to port workers. Industry statistics show that mooring related incidents are among the leading causes of injuries and fatalities in port operations.

### RightShip<sup>1</sup> Statistics and Insights on Mooring Safety:

Based on feedback reports from 101 ports between 1 January 2016 and 31 December 2024, performance across various operations were assessed and reported to RightShip. The most critical feedback related to mooring operations, indicating that vessel performance – whether due to equipment, process or personnel – fell below expectations.

Snapped mooring lines cause dozens of serious accidents annually, with estimates suggesting that up to 10% of port-related injuries involve mooring operations. These incidents often result from excessive tension or improper handling, highlighting the urgent need for safer alternatives. Beyond the human cost, mooring-related accidents lead to substantial financial consequences, including medical expenses, liability claims, and rising insurance premiums.<sup>2 3</sup>

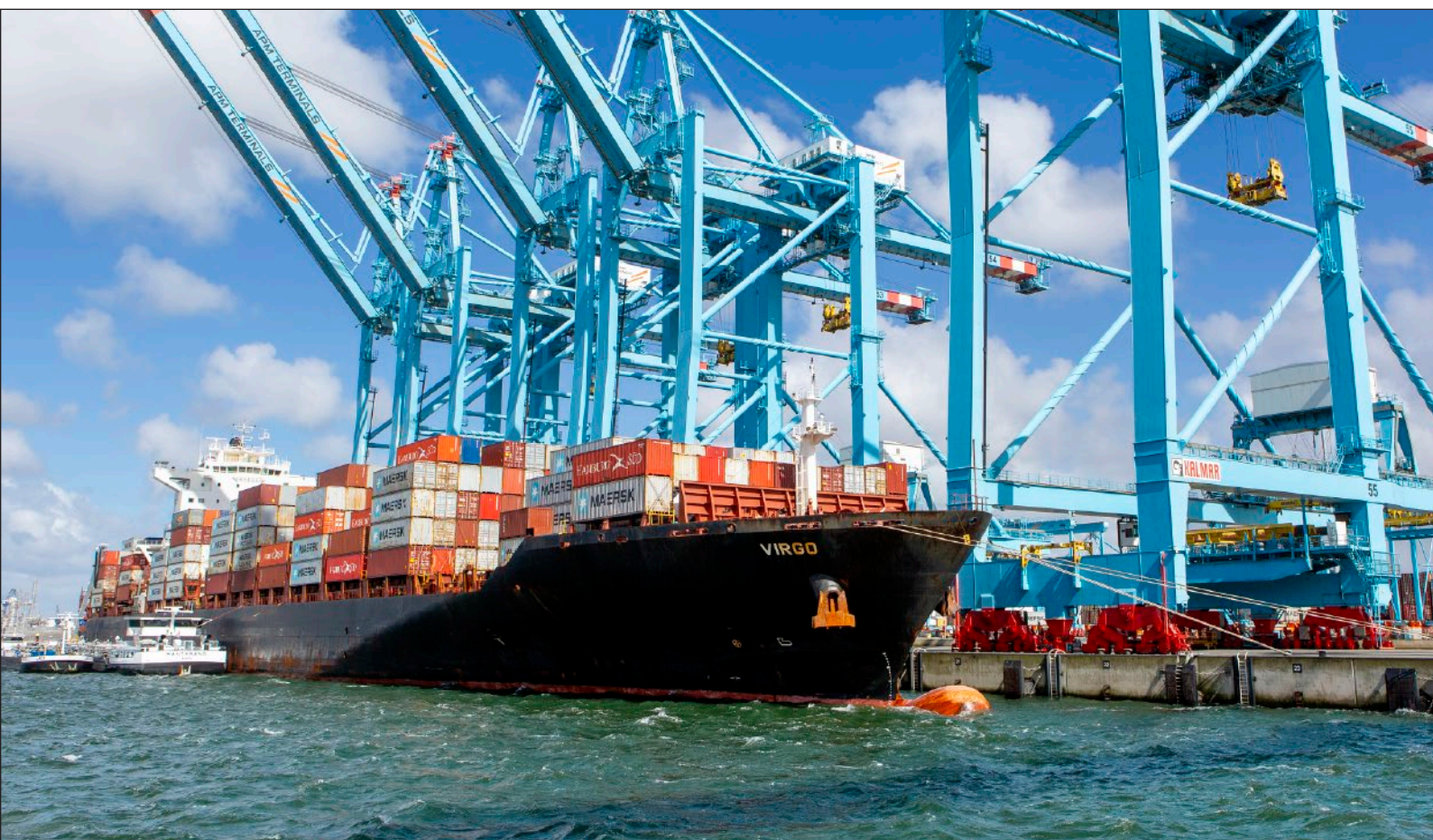


<sup>1</sup> Link: <https://www.dnv.com/expert-story/maritime-impact/A-new-look-at-safe-mooring/>

<sup>2</sup> Link: <https://www.westpandi.com/news-and-resources/loss-prevention-bulletins/accidents-during-mooring-operations/>

<sup>3</sup> Link: <https://www.maersk.com/logistics-explained/transportation-and-freight/2024/08/13/unloading-a-vessel>

<sup>4</sup> Link: <https://www.nature.com/articles/s41467-018-08066-0>



# MoorMaster vs. Mooring Lines: A Game-Changing Solution

Vacuum-based automated mooring systems like MoorMaster offer key benefits, drawing from Cavotec's extensive experience in the market over the past 20 years with more than 3 million moorings done with the system. The table below provides a comprehensive overview of the main benefits from implementing an automated mooring system. These benefits include faster operations, enhanced safety, and significant environmental improvements, underscoring why automated mooring is a game-changing solution for the industry.



MoorMaster represents a transformative leap in mooring technology, delivering notable advantages over traditional mooring lines. To encourage readers to explore the detailed comparison table below, here's a brief summary of its key benefits: MoorMaster significantly reduces mooring times, enhances safety by eliminating manual handling, stabilizes vessels for improved crane productivity, and reduces environmental impact by cutting emissions from idling ships. These advantages highlight why automated mooring is becoming an essential innovation for modern terminals.

## Key Differences Between MoorMaster and Mooring Lines

FEATURE	MOORING LINES No situational awareness	MOORMASTER High situational awareness
<b>Mooring Time</b>	30-60 minutes	~30 seconds *
<b>Safety and Security</b>	High risk of accidents	No manual involvement, safer
<b>Vessel Stability</b>	Limited, affected by environment	Superior stabilization through active hydraulics, increasing crane productivity
<b>Labor Requirements</b>	Requires manual workforce	Remote operation, automated
<b>Environmental Impact</b>	Vessel idling during mooring, longer use of tug boats	Reduced fuel usage from vessel and tug boats

\* from pressing the 'moor' button on MoorMaster till the system has safely secured the vessel

## Advantages of MoorMaster

- **Faster Operations:**  
MoorMaster's automated vacuum pads secure vessels in under a minute, reducing idle times and improving terminal throughput. This efficiency allows the workforce to be deployed in other critical areas of terminal operations.
- **Improved Vessel Stability:**  
The system's precision stabilization minimizes vessel movement, leading to faster, more consistent crane operations.
- **Reduced Environmental Impact:**  
The faster mooring process reduces fuel consumption and emissions from idling vessels, helping create more sustainable port operations.
- **Enhanced Safety:**  
By eliminating manual mooring lines, MoorMaster keeps workers out of high-risk zones, drastically reducing the chances of accidents and fatalities.

MoorMaster's ability to address these challenges holistically makes it a valuable investment for terminals looking to modernize and optimize their operations.





# Project Overview

To validate the capabilities of MoorMaster’s in container terminals, Cavotec worked together with APM Terminals at Tanger Med 2, a leading container terminal located in Tangier, Morocco. APMT Tanger Med 2 has invested in the MoorMaster technology for two of their berths. The objective of this project was to determine the system’s benefits on productivity and efficiency.

Excerpt from an APM Terminals Tanger Med 2 news article:

### **“Auto-mooring to reduce call times**

*The system will reduce time spent by tugs in port – reducing emissions – and faster turnaround means each vessel can cruise more slowly and efficiently to its next port of call. According to Cavotec, the system can reduce direct emissions during ship berthing by more than 90% due to reduced use of tugs and ship engines.*

*Once ships are moored, the system’s active hydraulics significantly reduce vessel motion, thereby positively impacting the terminals already exceptional crane moves per hour. APM Terminals MedPort Tangier consistently achieved productivity levels above 30 crane moves per hour in 2021 and is on target to increase this to 34 in 2022. As a result of improved efficiency, average vessel call times are expected to be reduced by an average of two hours (in addition to the saving of one hour due to faster mooring and release times).”*

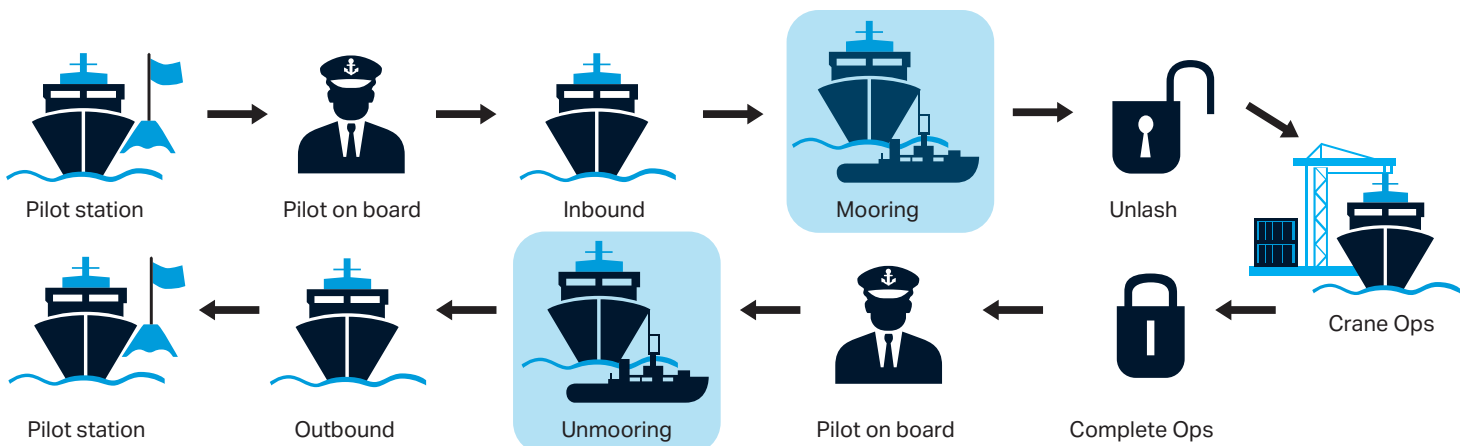
## Terminal Background

Tanger Med 2, operated by APM Terminals and located in one of the busiest global shipping hubs, has an annual capacity of processing 5.2 million of TEUs annually. The terminal consistently strives to be a leader in the container handling industry by adopting best practices and state-of-the-art technologies to serve its customers efficiently and safely. This commitment to excellence drove Tanger Med 2 to explore innovative solutions like MoorMaster to enhance safety, efficiency, and overall terminal performance.

- **Quay length:** 2.000 meters
- **Berths:** Five in total (two of which are equipped with MoorMaster systems)
- **Yard area:** 60 hectares
- **Annual capacity:** 5.2 million TEUs
- **Operational since:** 2019, with concession until 2046

## Implementation Process

The MoorMaster system was installed at a designated berth and integrated with the terminal’s existing infrastructure. Terminal staff received training on system operation and monitoring. The project ran for 10 months, during which data on mooring times and crane productivity were collected.



## Objectives and Scope

The project aimed to evaluate MoorMaster's impact on:

- Mooring and unmooring times.
- Ship-to-shore crane productivity through improved vessel stability.

## Data collection

To ensure an accurate evaluation of MoorMaster's impact, the following measurement methodologies were implemented:

### Mooring and Unmooring Times:

Tanger Med 2 and the Port Authority of Tanger Med deployed a phased approach to measure mooring efficiency.

- **Phase 1:** Initially, vessels moored using traditional mooring lines alongside the MoorMaster system, with no change to the traditional mooring process. The goal of this first step was to allow all involved parties – including terminal employees operating the MoorMaster units – to become familiar with the technology.
- **Phase 2:** Once familiarity with the system was established, the process evolved. A double line was deployed for stern and bow (safety lines), followed by securing the vessel entirely with MoorMaster. This adjustment allowed terminal operations, such as the 'first lift,' to begin significantly sooner than with traditional mooring lines, effectively reducing overall mooring times. By adopting this new process, Tanger Med 2 reduced the deployment of 50% of the mooring lines.

Further optimizations to the current Phase 2 process are being discussed for future improvements.

### Ship-to-Shore Crane Productivity Through Improved Vessel Stability:

To evaluate MoorMaster's impact on crane productivity, comparisons were made between berths equipped with MoorMaster and those without.

A detailed measurement process focused on 'Crane Cycle Times' to isolate the benefits of vessel stability. This approach excluded General Moves Per Hour (GMPH) data, which could be biased by factors unrelated to MoorMaster, such as waiting times or technical issues.

Specifically, the measurement process included:

1. Starting the timer when the crane PLC recorded the 'lock spreader' command.
2. Recording the time taken for the operator to load a container onto the vessel.
3. Excluding waste factors, such as waiting times, parking, and technical breakdowns, to ensure a fair evaluation.

Furthermore, comparisons were conducted on above deck and below deck, windy and non-windy days, ensuring similar conditions for vessel size, location, crane type, and move volumes across the two berths. This methodology provided a robust assessment of MoorMaster's ability to improve crane cycle times through enhanced vessel stability.





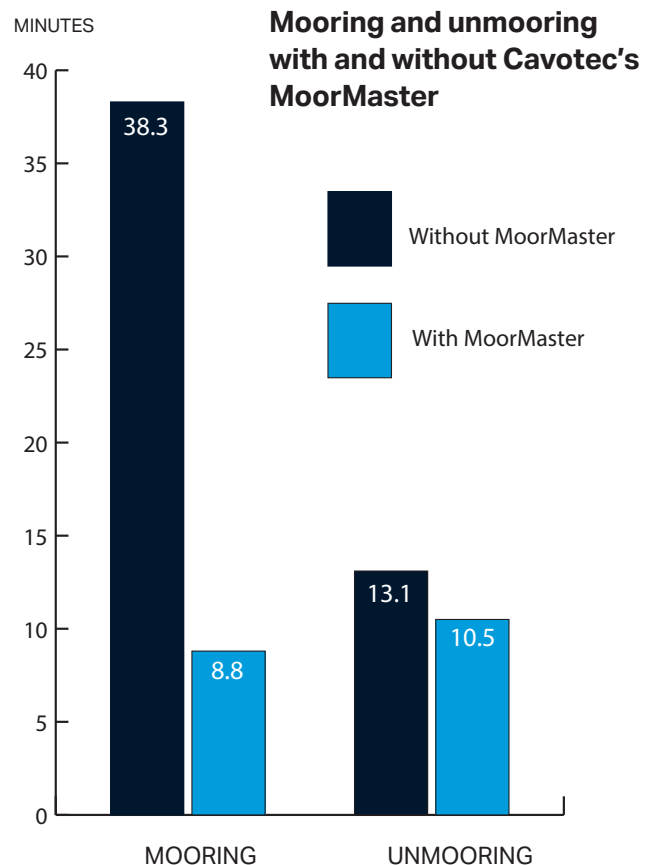
# Project Results: Productivity and Efficiency

The project delivered compelling results that underscored MoorMaster's transformative potential. MoorMaster delivers benefits even at a state-of-the-art terminal like APMT Tanger Med 2, although the terminal was already achieving impressive crane moves per hour before MoorMaster's installation, underscoring its superior capabilities in enhancing high-performing terminals.

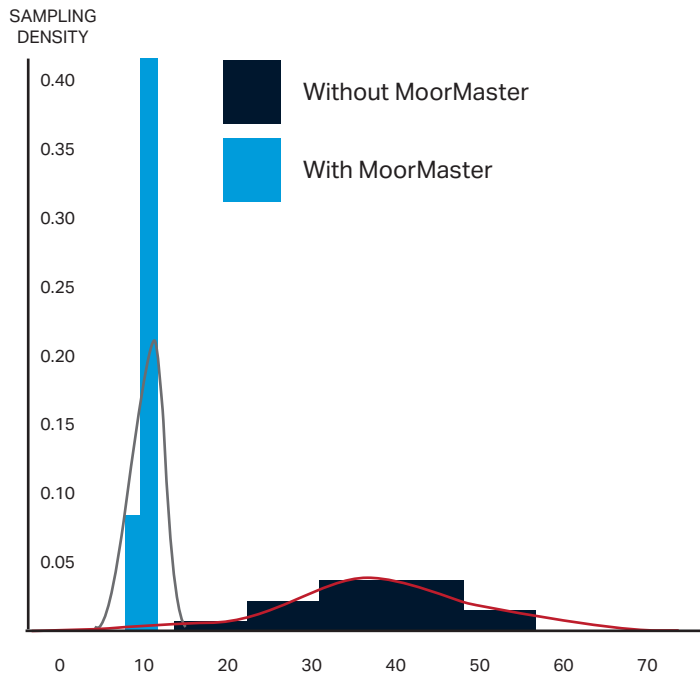
## Productivity Gains

### Mooring/Unmooring Time:

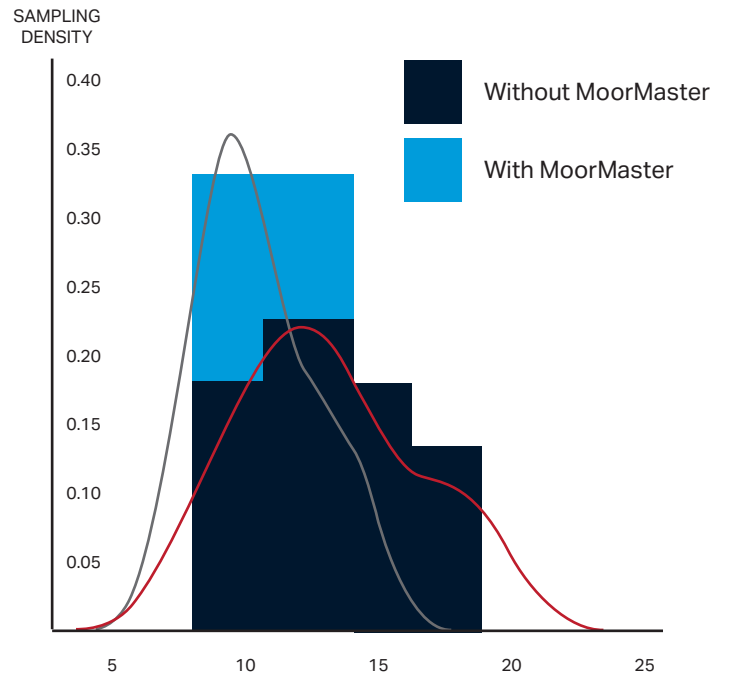
- Measurements: after implementation of the new mooring process aligned with the Tanger Med Port Authority in October 2024, on average 20 vessels per month are being moored with MoorMaster.
- Results: Mooring times were reduced from an average of 40 minutes to 10 minutes, enabling faster vessel turnarounds. The time from First line to First lift has been reduced. This gave the terminal an improvement of around 71%. Unmooring times were reduced from 13 minutes to 10 minutes, giving the terminal an improvement of 23%.
- Conclusion: Mooring times have significantly improved due to MoorMaster as seen in the results above. As discussed on page 9, Tanger Med 2 and the Port Authority of Tanger Med deployed a phased approach to measure mooring efficiency. The process with mooring lines can be optimized even further to improve the mooring times and unmooring times.



## Mooring



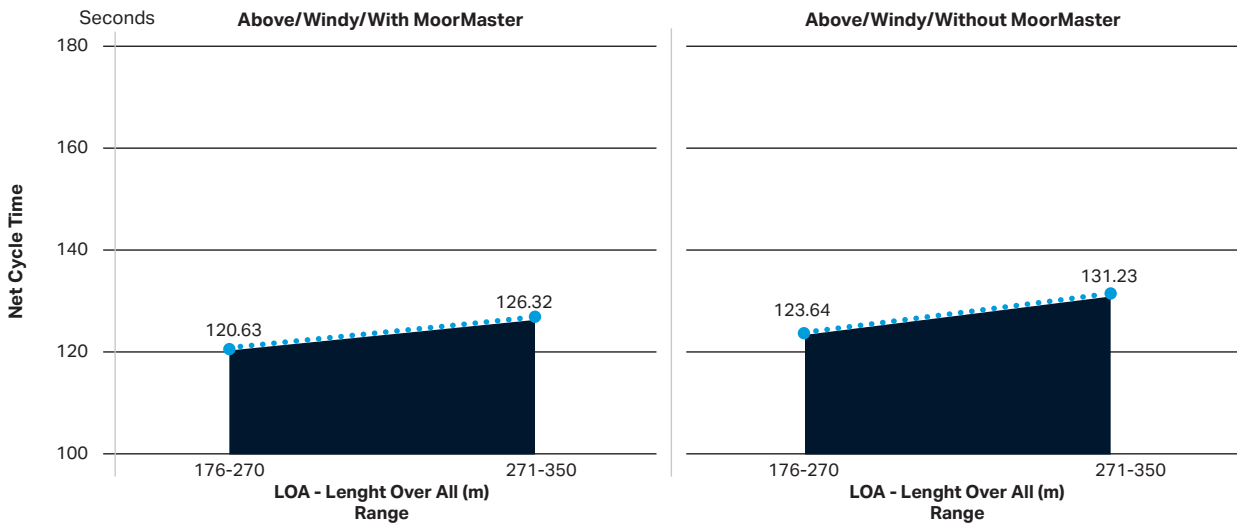
## Unmooring



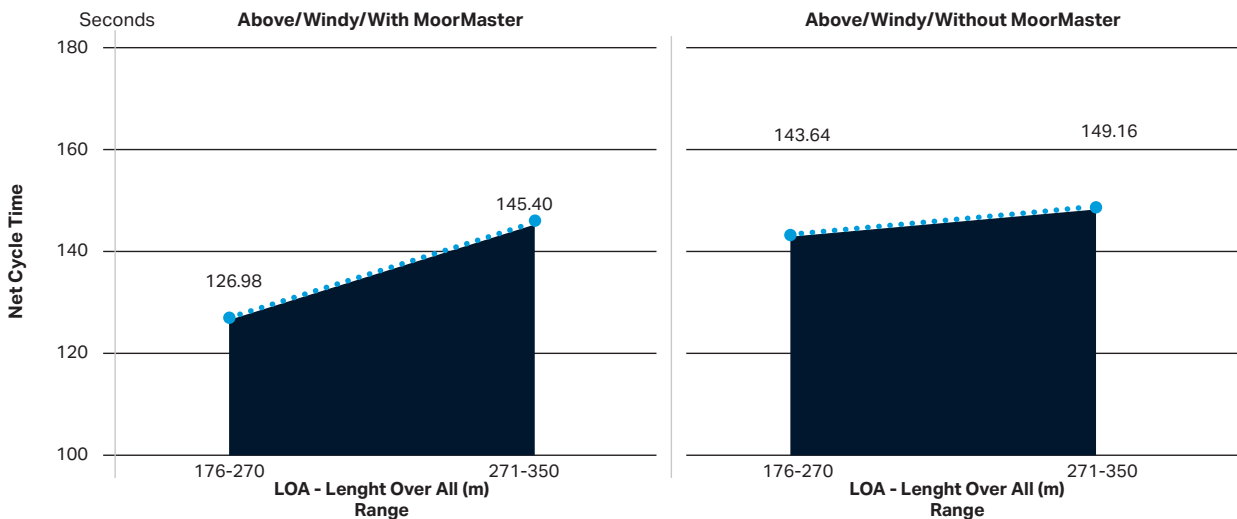
### Crane Productivity:

- Measurements:** more than 65.000 crane cycle times were measured with MoorMaster. Equal amount of 65.000 crane cycle times were measured without MoorMaster.
- Results:** Crane cycle times are improved by approximately 3% in normal weather conditions above deck. Below deck during normal conditions, the crane cycle times are improved by approximately 6%. Crane cycle times above deck are improved by approximately 4% in bad weather conditions. Below deck during bad weather conditions, the crane cycle times have improved by approximately 11%. Summarized, by implementing MoorMaster terminal operators can expect at least an improvement of crane cycle times between 3% - 11% at already well-performing terminals.
- The below graphs illustrate the MoorMaster performance in 'No Windy Conditions' and 'Windy Conditions'. No Windy Conditions represent normal weather conditions in Tangier while Windy Conditions mean higher winds than usual, often considered as 'winter period' in Tangier. This period is accompanied with higher wind speeds than usual, making crane operations more difficult and thus more unproductive than normal weather conditions.

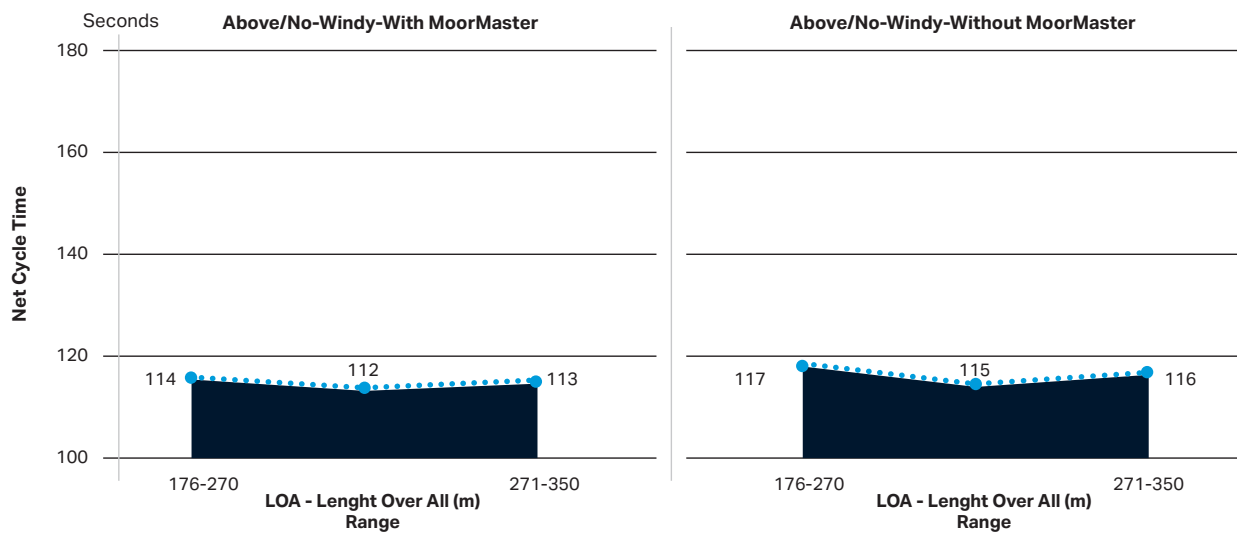
### Comparison of Crane Cycle Times in Windy Conditions Above Deck Position



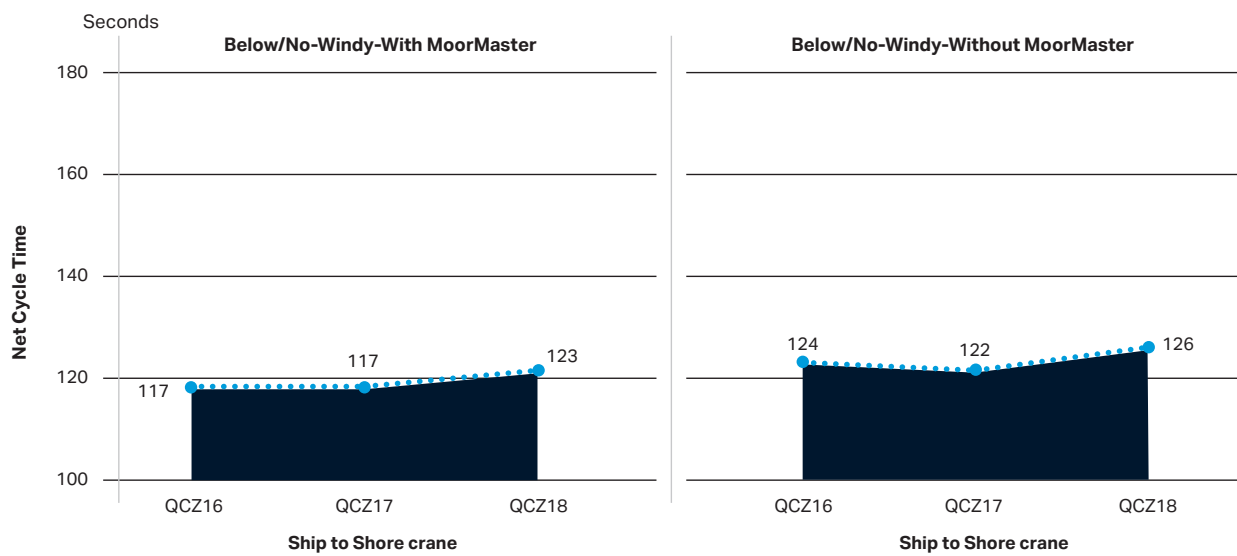
### Comparison of Crane Cycle Times in Windy Conditions Below Deck Position



## Comparison of Crane Cycle Times in no Windy Conditions Above Deck Position



## Comparison of Crane Cycle Times in no Windy Conditions Below Deck Position





# Broader Implications for the Shipping Industry

MoorMaster's success extends beyond individual terminals, offering industry-wide benefits:

## For Terminals

- **Enhanced Competitiveness:** Faster operations and increased throughput make terminals more attractive to shipping lines.
- **Cost Efficiency:** Lower labor demands and improved safety reduce operational costs.
- **Future-Ready Operations:** Investing in MoorMaster prepares terminals for increasing trade volumes and stricter safety and environmental regulations.

## For Shipping Lines

- **Lower Costs:** Reduced port stays decrease fuel consumption.
- **Schedule Reliability:** Faster and more consistent mooring processes enhance schedule adherence, benefiting supply chains.
- **Improved Partnerships:** Shipping lines prioritize terminals with reliable, high-performing infrastructure.

## For the Industry and community

- **Sustainability:** MoorMaster's ability to reduce emissions aligns with global environmental goals.
- **Safety Leadership:** Widespread adoption of automated mooring systems can drastically reduce injuries and fatalities across the industry.
- **Efficiency:** Automated mooring enhances global operational consistency and efficiency.



# Conclusion: Why Stakeholders Should Invest in MoorMaster

## For Terminals

Investing in MoorMaster offers a competitive advantage by enhancing throughput, improving operational efficiency, increasing safety, and reducing operational costs. Terminals adopting this technology can position themselves as industry leaders, attracting more business from shipping lines and improving overall profitability. MoorMaster delivers benefits even at a state-of-the-art terminal like APMT Tanger Med 2, even though the terminal already achieving impressive crane moves per hour prior to MoorMaster's installation, underscoring its superior capabilities in enhancing high-performing terminals. Greater benefits can be anticipated at terminals facing environmental challenges.

## For Shipping Lines

MoorMaster helps shipping lines save time and money by ensuring faster turnarounds and more predictable schedules. Terminals equipped with MoorMaster also offer safer and more efficient handling, strengthening partnerships between terminals and shipping lines.

## For the Global Industry

MoorMaster aligns with industry-wide goals for sustainability, safety, and efficiency. Its adoption on a larger scale would not only modernize port operations but also contribute to a safer and more sustainable global supply chain.

By investing in MoorMaster, stakeholders can future-proof their operations while reaping significant immediate benefits. Contact us to learn more about how MoorMaster can transform your terminal or shipping operations.



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