



Whitepaper

Envisioning a Safe and Productive Maritime Ecosystem with AI



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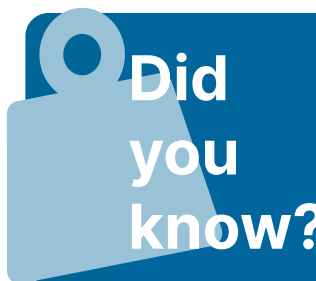
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Introduction

In this age of globalization and technical change, the expansion of international maritime trade has surpassed all anticipations. The circulatory system of our planet, currently valued at \$14 trillion, witnesses over 11 billion tons of cargo hauled in and out of the ports every year.

This number includes critical life-sustaining materials amounting to 2 billion tons of crude oil, 1 billion tons of iron ore, and 350 million tons of grain. If we divide this amount by the global population, we are looking at the movement of 1.5 tons of cargo for every single person.

The total value of the annual world shipping trade has been recorded at more than 14 trillion US Dollars in 2019 and is expected to touch 20 trillion US Dollars by 2025.



Did you know? Shipping offers the cheapest mode of transport per ton: sea transport contributes just 30c to the \$2.50 cost of a cup of coffee, 20c to the \$5 cost of a wine bottle, and \$5 to the \$100 cost of a Nike trainer.

Marine transport industry is capable of transporting goods cheaply, in large volumes, and with a minimal environmental footprint.

A Tale of Ever-Expanding Horizons

Already, ports are extremely busy and sprawling places, owing to the sheer scale and sophistication of operations they have been purposed for. A large port can be larger than a city. The port of Shanghai ([3600km²](#)) is five times larger than the city-state of Singapore ([700km²](#)).

Considering the size and operational scale factors, managing a port can be as challenging as managing a city. Port operations involve specialized activities which may witness incidents like personnel going overboard, falling from heights, or getting hurt from slips/trips/object strikes, collisions or meeting with driving related accidents



The Port of Shanghai

Any safety accidents whatsoever may lead to disruptions, unprecedented logistic delays, and even gaps within the supply chain as a ripple effect.

When compounded with the rate of expansion (15-20% for developed countries and 28-30% for developing countries), we can see this situation is only going to worsen as the risk factors multiply. Thus emerges the challenge of efficiently managing a surging workforce, swelling volumes of cargo, and additional infrastructural installations while also watching out for safety.

Managing Safety and Productivity at Ports

Ports are dynamic environments with high traffic and personnel density operating various powered industrial equipment, semi-trucks, forklifts, toolsets, and other paraphernalia. Port work involves strenuous repetitive tasks capable of fatiguing and hence clouding systems that are over-reliant on human feedback.

Research has indicated that between 2011-2016, 1 in every 20 port workers was either injured or fell ill as a direct consequence of their employment.



Port Terminal is the beating heart of a port. 34% of all LTIs (Lost Time Injuries) have been reported within the terminal zone. Categorically, some 14% of these accidents were caused by improper manual handling, 31% by slips/trips/falls, 20% by hits (stationary/moving/flying/falling objects), and 17% by driving.

Managing a terminal for safety involves watching out for critical dangers like



Falls from Height

Activities like container top work, loading/unloading/sheeting, or gantry crane maintenance work carry risk of falling from heights.



Driving / Cargo Handling

Account for 17% of all terminal accidents. Cargo trucks, forklifts, trailers, winching carts, and other specialized vehicles often must ply in constrained terminal space shared with human workers.



Slips, trips, and light object strikes

Responsible for 25% of all reported accidents, these are generally serious cases contributing 42% to LTIs. Even a screw falling from a gantry crane has enough kinetic energy to penetrate a human skull.]

Safety Incidents adversely affect the port's productivity and lead to unprecedented losses, delays, and congestion. Often, the pace of operations must be restrained in order to maximize safety. This comes as no surprise, owing to the highly technical nature of operations.

The efficiency of a port usually factors in 3 stages of operations: maritime, terminal, and hinterland, but ultimately, everything boils down to the container handling operations which account for more than 60% of the total time a ship spends on port.

Lifting and hauling operations are the most important, sophisticated, and dangerous of activities carried out at the port terminals, making them a crucial factor for maritime ship-

ping companies.

A delay of 5 mins (~2 lifts) in lifting and hauling (crane operations) can increase the total turnaround time by 23.8 mins, when factoring in all shuffles, shift changes, dependent verification processes and rest hours. That is a massive 4X damage to productivity as ripple effect.

The period 2020-21 has already seen a rise in overall shipping times by 25%, with the average delays surpassing the 1.5-day mark. Comprehensibly the operational costs have also shot up by 25%, costing the industry more than \$34.71 billion in 2021 in unpredicted overhead expenses. The US east coast is the worst hit when considering the transpacific rates which having increased by about 3.5 times over the course of last 20 months.

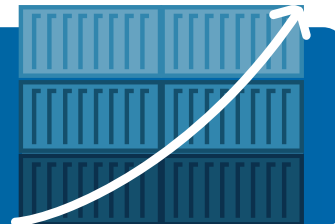
Shipping is critically important to our pursuit of a carbon efficient logistics system

In total, ports are responsible for carrying 80% of global trade by volume and 70% by value.

The sheer volume is so high that these “ship”-ments (pun unintended) would not be possible by road, rail, or air.



This volume itself is a massive 1500% increase over the last 50 years, and the trend continues to grow at a daunting rate of 30.25% per annum for major ports and 18.19% for minor ones.



Analyzing Elements of Human Performance

Since port work for most part is characterized by strenuous and repetitive tasks capable of fatiguing and stressing the systems, analyzing elements of the same presents us with a good point to start.

In a tug-of-war between safety and productivity, if either side wins, both lose. Safety and efficiency may at times tend to compete for priority but are not mutually exclusive.

In 80-90% of risk events logged at ports, “Human Error” was recognized as a root cause. However, when dissected for detail, the reasons for error have ranged from fatigue, carelessness, stress, health, lack of situational awareness and mistakes due to inadequate training or poor safety culture.

A better term for human error would therefore be, the misallocation of human intelligence.

The Misutilization of Human Intelligence

Reasoning, problem-solving, and learning are crucial facets of human intelligence. Armed with the powerful reasoning ability, people have been able to solve virtually every problem humanity has ever faced.

In doing so, the human intelligence integrates multiple cognitive functions such as perception, attention, memory, and language. Over the course of human evolution, our mind has grown extremely well adapted to handling complex tasks.

The same adaptation gets challenged when the task at hand does not resonate with the natural tuning of our cognitive abilities.

Tasks involving continuous supervision of activities like the alignment of trucks with crane blocks, container stacking, and grabber alignment during raw material loading/unloading are repetitive in nature and hence capable of clouding human judgement. In addition to being monotonous, the nature of accidents is sudden and unexpected. Add to that the area and ratio where a single safety officer must supervise more than 300 workers over an area of thousands of square feet, and we have a perfect recipe for disaster.

Safety officers in charge of supervising the lift can have biases when it comes to container/grabber positioning because natural depth perception of the human mind is limited to about ~10 meters. Beyond that, the brain uses certain clues (objects being smaller when farther away, shadows, contrast, etc.). While the human brain is indeed good at guessing how an object would look if it were closer and farther away to build a 3D image, it cannot gauge the depth with accuracy.



Image appears 3D but in fact it is 2D

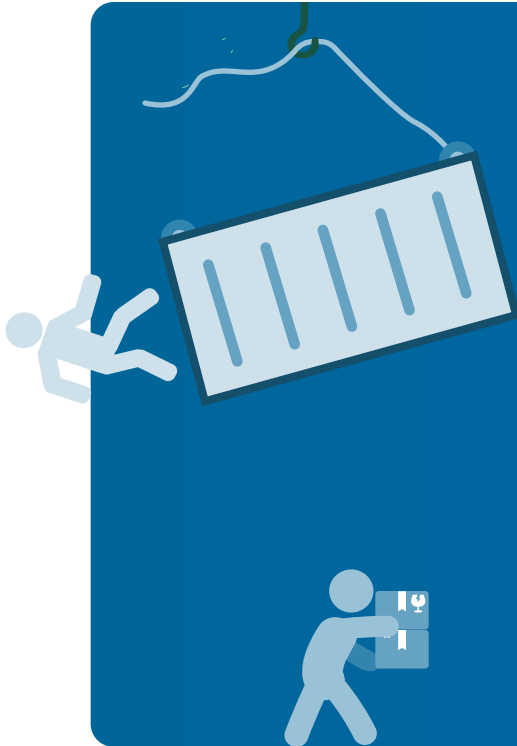
That is why it is imperative to understand that this is not “true” depth perception. It can be easily tricked. One example is that of 3D painting. A 2D picture of railroad tracks going off into the distance can be easily interpreted by the brain as 3D, only because the tracks narrow at one end.

The Unrealistic Expectations from Human Performance Elements

A major downside of misallocating human intelligence is that it inspires unrealistic expectations from on ground personnel. Through the following cases we aim to highlight how these misallocations and unrealistic expectations end up bottlenecking the most important activities in the port's daily operational routine.

Container Crane Blind Spot and Distance Gauging Bottle-necks

[An analysis](#) of 249 industrial overhead crane incidents over 10 years revealed a disturbing 90% fatality rate across a total of 838 OSHA violations. Economically, the violations led to \$2.3 million in OSHA fines. The average major injury has a cost of over \$200,000, while the average fatality has a cost of over \$4 million.



Crane Incidents

-In 37% of the cases, victims were crushed by the load (reasons included load swings, load drops, or unstable loads toppling over). Getting crushed by the load resulted in 33.8% of all fatalities and 36.8% of all injuries.

- In 27% of the cases, loads dropped on unsuspecting victims.

- In 12% of cases, the cause was "falls from heights" (between 8 to 100+ ft.)

- In 11% of cases, an Injured Person was crushed/run over by a Gantry Crane.]

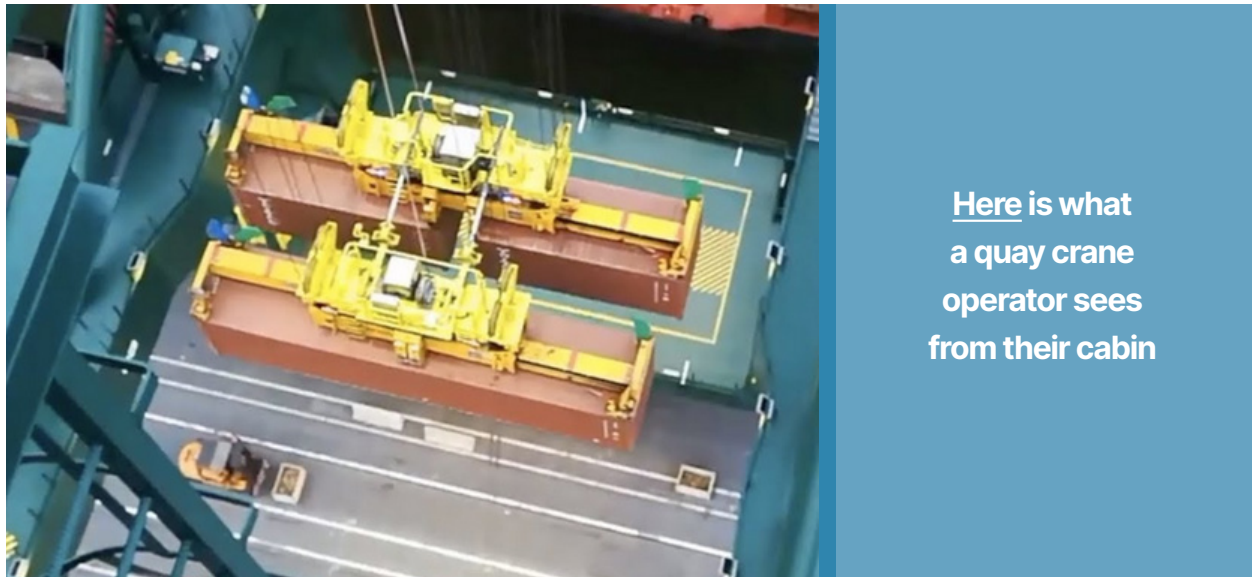
At port terminals, container cranes must load and unload thousands of containers almost continuously. While loading/unloading the containers on trucks/ITVs, the truck driver must align the truck with the container being hauled. This alignment must be perfect for the container to be secured to the truck properly, or else it can cause accidents.



Container placement on a truck

Operating quay cranes requires a high degree of skill and coordination. Gauging distances accurately from 140 ft above the ground is difficult and the opacity of the container leads to the formation of a perpetual blind spot. There is no way the operator can see if someone is standing under a suspended load.

The complexity of the issue remains unchanged for a ground-based person trying to accomplish this task. This current system therefore inherently exposes the operation to risks making it unsafe and inefficient.



Owing to the blind spot, a lot of time is wasted in shuffling the truck for correct alignment, increasing the loading time for each container. As we factor in the domino effect, these delays can compound over multiple iterations and lead to congestions and capacity issues by increasing the overall turnaround time.

Container Stacking and Shuffling Bottlenecks

The fact that containers can be stacked is itself a lifesaver for port logistics. It allows the ports to store multiple containers in an efficient manner.

However, containers are designed such that they need to be stacked directly on top of each other for proper distribution of cargo weight. If there is a misalignment anywhere, the center of gravity of the entire stack is affected and there is a risk of containers sliding and toppling over.



A toppled stack

This stacking of containers, just like their placement on a truck or ITV, is another alignment and positioning nightmare. There is a perpetual blind spot, there are distances that need to be gauged accurately and the overall process, once again, comes to rely heavily on manual feedback.

Container Stacking contributes directly to the overall turnaround time of a terminal. While the stacks are planned meticulously, keeping the shipping schedule in mind, disruptions in are not all that uncommon. [In almost 42% of delayed arrival cases](#), additional work is often required if the bottom container is needed earlier than a container stacked on top of it.



Containers to be serviced stored in stacks

Situations of this kind that involve completion of a precision task in limited time often end up stressing the personnel, thus exposing the operations to known risks.

Managing Raw Material Loading and Unloading Operations for Safety and Productivity

Cargoes such as coal, metal ores, sand, grain, coke, gravel, aggregates, biomass, fertilizers, etc. must be transported through a purpose-built mechanism. The process involves the grabber being lowered into the cargo bulk, the material being grabbed, before it is finally hauled.

As the hold is filled/emptied, machines such as excavators and bulldozers are used to keep the cargo in check and maintain the heap. In case of a faulty distribution of weight, there is a perpetual danger of the vessel capsizing or even breaking in half!



**Lack of visibility
inside the hold
slows down the
navigation pro-
cess.**

Once again, the container crane blind spot comes into play. If these operations are not carried out with utmost caution, there is a high chance of collision between the grabber and the earthmover or grabber and the hatch.

During unloading operations, when the grabber is lowered into the bulk carrier's open hatch, the crane operator loses even the limited sight, leaving them unable to judge the grabber's position.

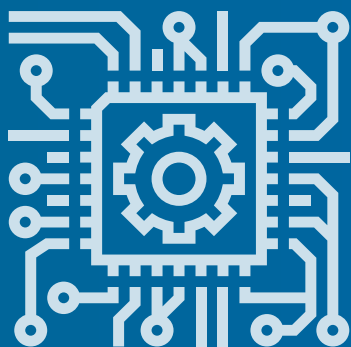
With the scale, scope, importance, and technicality of these operations being critically high, a minor noncompliance can have adverse and often far-reaching consequences on the overall viability of port operations. In such a situation, it becomes important to supplement the human decision-making ability with the necessary awareness, to help the personnel take informed decisions in real time.

Extending Human Capabilities with Actionable Insights

Information is essentially useful data.

To be able to prevent losses emanating from actions based on anecdotal evidence, it is essential to make good use of data. The availability of stats facts, metrics, and data to guide strategic decisions that align with end goals and flexible objective is essential.

If leveraged properly, data can be a significant productivity driver. Well managed data can highlight areas for improvement and help with better awareness. KPI measurements suggest a minimal ROI of \$2.87 million on a 10% increase in intelligence and accessibility of data.



AI has got your back!

- Automatic reporting and categorization of incidents negates incorrect data entries
- Intelligent analysis helps obtain meaningful insights
- AI trained with these insights streamlines operations

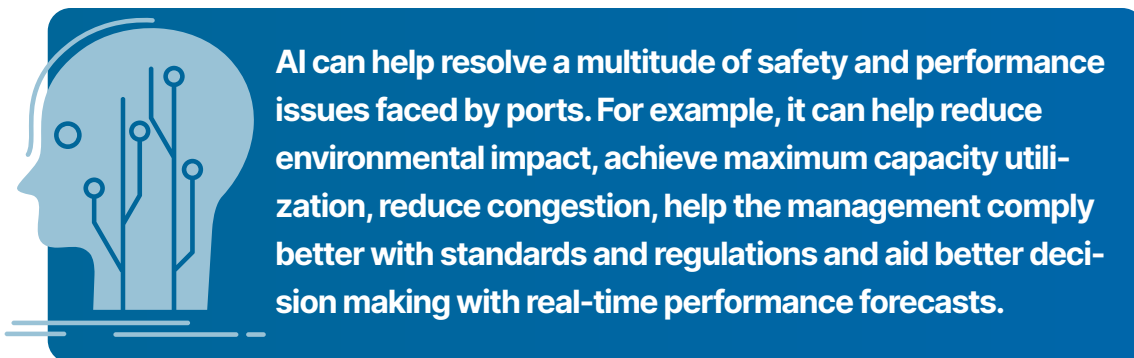
Why AI and ML for Ports is a Good Idea?

As humans, we observe our surroundings using eyes. We learn as we gain context to differentiate between objects, observe patterns, gauge distances, calculate movement speeds, and spot mistakes.

A similar process is followed when we try to make a machine learn something. Using a combination of cameras, algorithms and data, AI-powered machines can be trained into carrying out these processes.

They can then analyze thousands of assets, activities, people, or products in minutes allowing detection and rectification of safety and efficiency bottlenecks indiscernible to the human eye, aiding the human thought and decision-making process at a much faster rate.

With port operations being procedurally repetitive, the availability, as well as quality of data recorded as incident logs, images, thermal inputs, or sensor readings, is perpetually high, making port operations an ideal ground for AI implementation.



By covering the operations comprehensively, AI can help cut redundant costs significantly.

Meet T-Pulse: The AI that Guarantees Comprehensive-ness at Scale

How significantly can an AI system help eliminate operational bottlenecks and increase precision depends on how well its algorithms have been trained. In simpler words, how

well has the information previously gathered, been utilized.

That is the reason why the industry's favorite tool for automating compliance management in fast paced workplaces comes pretrained with the largest dataset in the world. T-Pulse has been trained to comprehensively cover your port operations across 170+ categories of noncompliance.

It has been designed to act as an autonomous system for preventing accidents, monitoring compliances, controlling access, tracking progress, and responding to changes to speed up operations while maintaining the highest standards of safety.

With T-Pulse taking over repetitive and fatiguing aspects of jobs like compliance monitoring, vehicle guiding, lift-ing, and hauling supervision, process tracking, etc. safety experts enjoy a higher time bandwidth that can be dedi-cated to process improvement.

Let's now look at some crucial aspects of port management that T-Pulse helps automate.

The Eye of Providence

T-Pulse pulse allows safety experts take a holistic approach to planning and execution of day to day port operations by creating a digital twin (real-time digital representation) of the port facility.

A real time digital representation helps secure operations throughout the facility by continuously monitoring it for compliance. T-Pulse can monitor compliances associated with port workers (safety gear, helmets, safety vests, etc.), assets (improper usage patterns) and processes (intrusion detection, standing under suspended load, safety harness, etc.) to notify the experts in real time.

Any signs of noncompliance, mechanical stress, inconsistencies, maintenance needs or

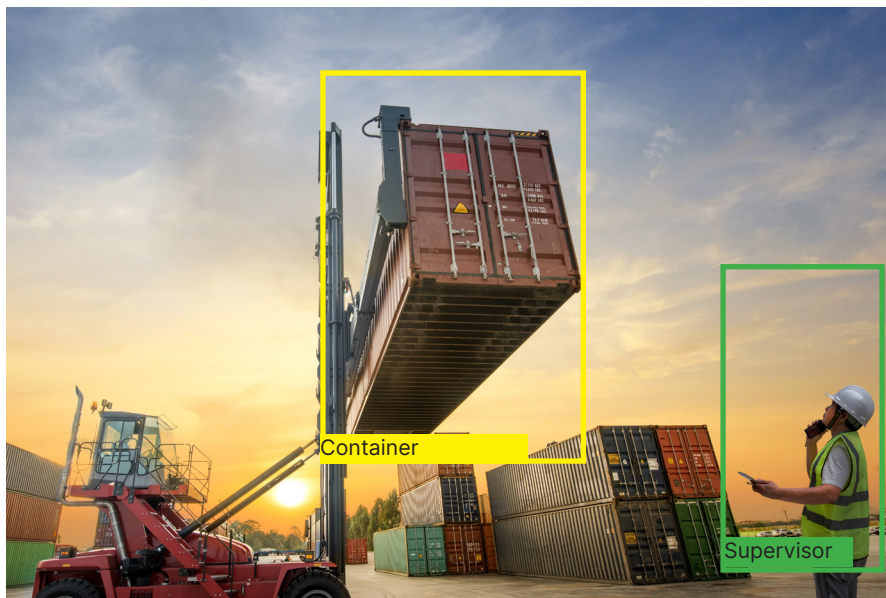


Seamlessly detect PPE and other compliances prone to oversight

improper usage patterns are identified and reported to ensure maximum safety, sustainability, and longer equipment life.

Detect and Prevent

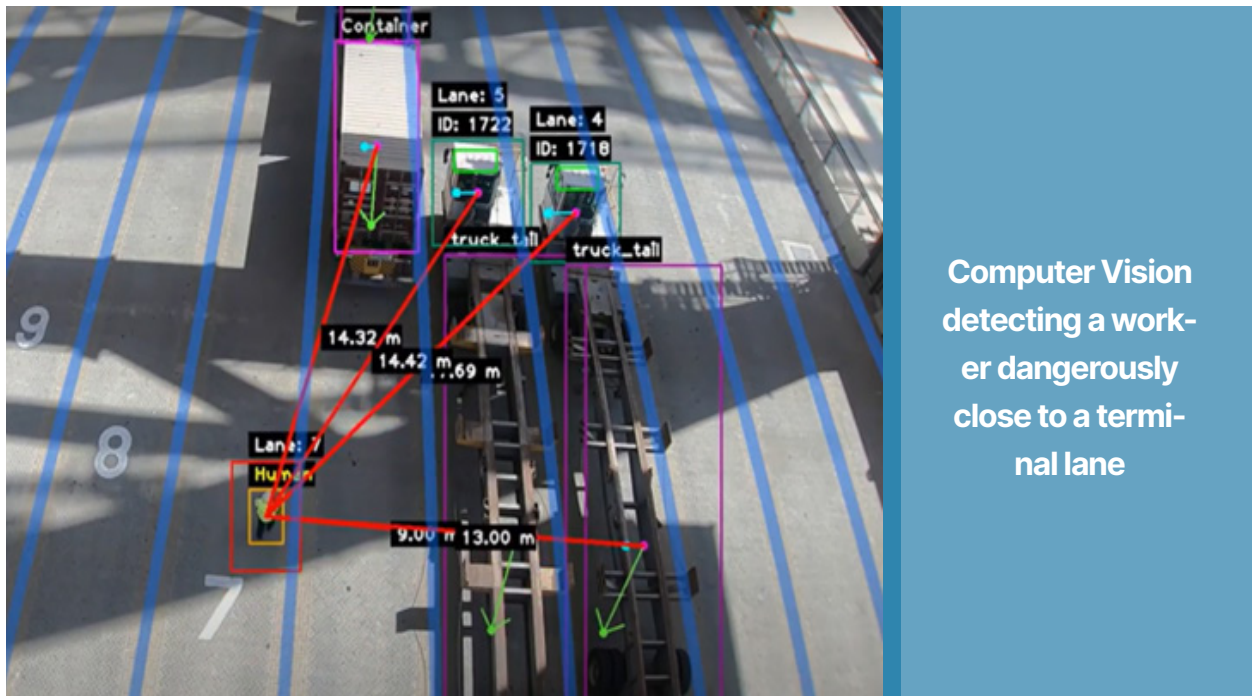
Real time analysis of visual inputs from cameras, reveals actionable information that can help prevent disruptions.



Detect possible collisions in real-time

There is no way someone watching this footage here with a generic CCTV would be able to detect a chance of collision between the officer on ground and the forklift or the forklift and the container stack.

T-Pulse can accurately detect the same by tracking the motion symmetry, calculating velocity, leveraging historical data, and other parameters in real-time and warn of an intersection or a possible collision.



Well trained algorithms can seamlessly parameterize objects to predict and guide maneuverability even within the congested port terminal environment densely packed with personnel, equipment and vehicles.

Ensure Proper Allocation of Resources

Port Operations require diverse skills. There are people trained for ferrying, lifting, hauling, driving, general duty, and special operations, like handling IMDGs (International Maritime Dangerous Goods). Provided the sophisticated nature of operations, the slightest mismatch in skill and task can lead to injuries, losses and disruptions.

Usually, manual verifications are needed preceding any such high-risk activity but follow-



Automatic
granting/
denial of
access

ing an initial round there is no way for safety experts to ensure if the skills get replaced as the operations proceed. Leveraging T-Pulse, managers can now be sure that the right people are deployed at the right place, 24*7 and at scale.

Preparing for Success



While compliance monitoring and proactive detection are all very good, a big change can only be brought by disseminating proper training on the grassroots level. By having data backed insights into areas of gaps, a greater emphasis can be redirected towards training the workforce for success.

Similarly, near-misses and safety incidents must be viewed as learning opportunities to eliminate hazardous conditions and unsafe practices before they cause injuries or disruptions. T-Pulse is proven to have reduced safety noncompliance in high-risk workplaces by over 92% in a matter of few months.

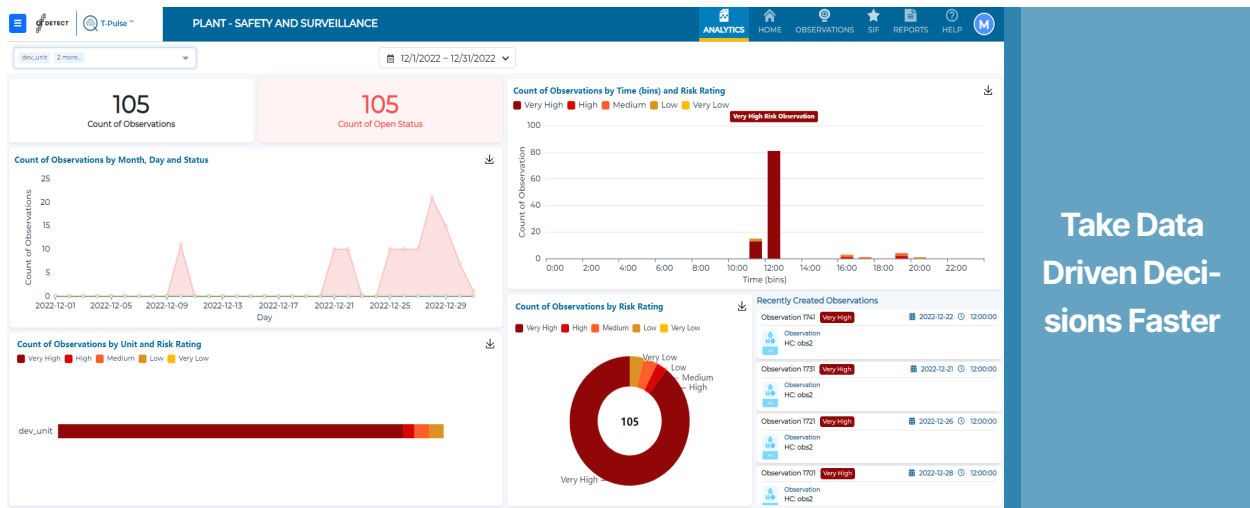
Visibility, Coordination and Management

A justified emphasis on individual HSE procedures, often leaves the overall system siloed

and in need of integration.

It is not unnatural to not be able to see the big picture but doing so is an essential step in the direction of Goal Zero.

Coordinating HSE compliances at ports requires real-time availability of data and interfaces capable of actuating and displaying all required parameters on a single screen, even remotely if possible.



Operational processes at ports are usually handled by different entities within the management. This makes it critical to have a single source for tracking and evaluating performance and compliance.

T-Pulse creates a unified port safety ecosystem that increases collaboration between different stakeholders by roping their individual roadmaps into one giant loop, allowing for mutually beneficial opportunities to improve efficiency through a better understanding of other stakeholders' insights, predictions, and constraints.

Fast, Safe and Faultless

T-Pulse helps resolve operational bottlenecks associates with container handling/lifting and hauling by effectively assisting human operators overcome natural biases.

Leveraging strategically placed cameras that continuously provide data to machine

learning algos, the AI uses visual inputs to fix the container crane blind spot. As soon as the algorithm detects the possibility of an incident, an alarm is triggered which alerts the operators and safety officers.



Whether it is the positioning of the containers in the form of a stack, or their hauling onto a truck, any misalignment is immediately reported, allowing for it to be rectified. This prevents accidents caused by container stacks toppling over or skidding off trucks during their transportation.

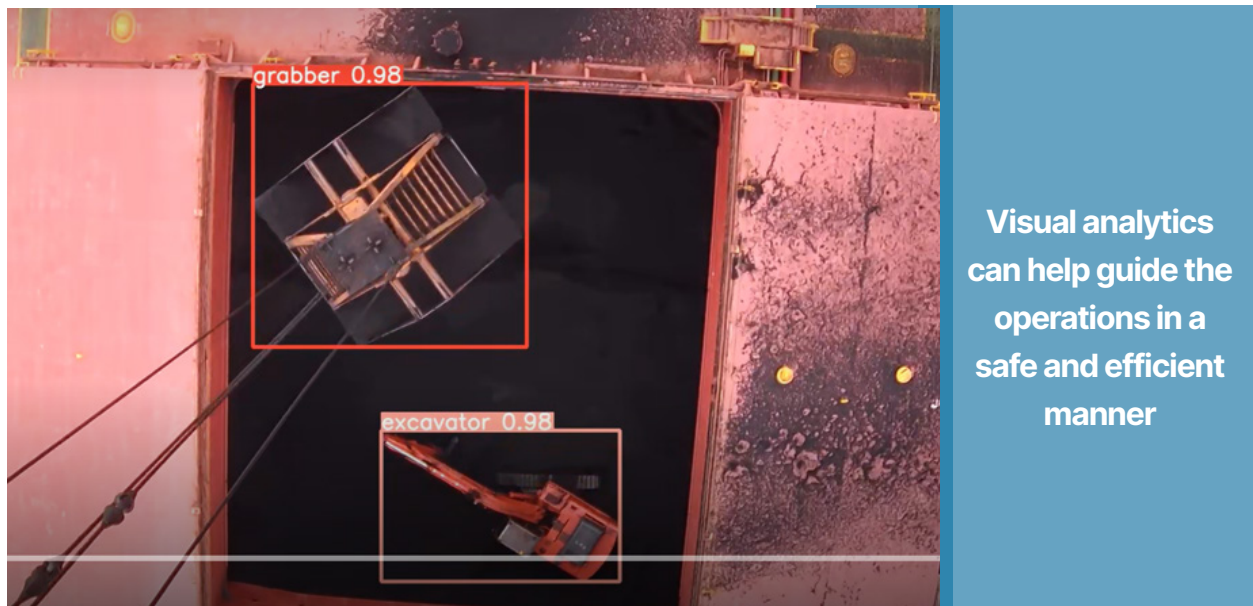
The visual 3D positioning system that powers T-Pulse, also allows it to better guide truck, forklift, crane, and ITV operators for faster parking/positioning. Truck/ITV drivers are guided with virtual markers to help with parking assistance for faster alignment with the crane block.



Crane/forklift operators, on the other hand, are guided with HUD based positioning sys-

system that allows them to position multiple containers throughout the ports with ease. With positioning time eliminated, the shuffling time (in case of a regular 4 container stack) gets lowered by at least 2 minutes (120s).

Similarly, T-Pulse can also streamline bulk loading and offloading operations and increase safety and productivity by continuously and accurately monitoring the bulk grabber's proximity, position, and movement.



In case there is a chance of collision between the grabber and the hatch or grabber and the excavator, an alarm is triggered, warning both the crane and excavator operators. HUDs with visual guidance indicators allow the operators to work seamlessly without the fear of collision. The crane operator can finally view the alignment of the grabber with the hatch and its navigation once inside.

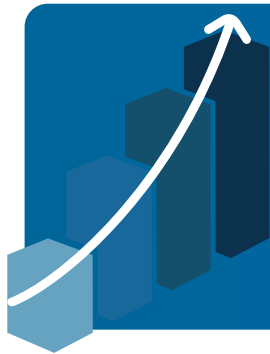
Intelligence provided by T-PULSE has been elemental in reducing both the scope of human error as well as per-container loading time by up to 30 seconds. Up to 7% of a direct increase in total cargo throughput and a 10% reduction in TCO (Total cost of ownership) have been observed.

T-Pulse also helps speed up the raw material loading/unloading process by up to 40s per haul and is especially beneficial for ports that lack hinterland cranes, where it can cut down the loading/unloading time by up to 50%.

Why T-Pulse?

Pressures from increasing international trade, stricter deadlines and mounting expectations from society all call for smarter measures like T-Pulse.

T-Pulse has already seen extensive deployment across multiple ports in India, (each growing at daunting rates of 30-32%) and preliminary reports suggest a significant boost to port sustainability. With T-Pulse, clients found a way to safeguard their workforce and handle more cargo in a safe and efficient manner.



T-Pulse is an affordable and smart alternative to comprehensive robotic terminal automation and expensive alignment sensors usually deployed to save lives and increase productivity at ports.

Translate the zero-incident and maximum-productivity goals to a commitment integrated with your port's business strategy today! Decide faster and better to save time and hassle with T-Pulse.

Sign up today for a demo.

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🌐 www.detecttechnologies.com