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WHITEPAPER 2021

HOW TECHNOLOGY IS TRANSFORMING **CONVENTIONAL VESSEL STOWAGE PLANNING**

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HARNESSING TECHNOLOGY FOR A HASSLE-FREE, SAFE, AND RELIABLE VOYAGE.

The container liner industry faces many commercial challenges and as a result it has renewed its focus to identify opportunities that maximize utilization of its vessels and ensure the safety of its fleet, crew and cargo.

These challenges have continuously motivated solutions experts to innovate and better leverage digitalization to satisfy the requirements of the liner shipping industry.

To better mitigate the risk of incidents and accidents at sea, there are many benefits to be gained from automating stowage planning. Using AI and machine learning processes, stowage planners and stevedores can optimize safety, cargo loading, lashing and Dangerous Goods stowage customized for each vessel.

When incidents do occur, having a digital record of precise stowage planning can aid salvage and rescue personnel in recovering units.

STUMBLING BLOCKS THAT CAN AFFECT VESSEL STABILITY AND STRESS LIMITS.

Planning the stowage of a container vessel in any liner company has always been the responsibility of a highly experienced and specialized team. They work in a high-pressure environment and have the responsibility to create well-structured stowage plans and always working with the knowledge that an inefficient stow could have severe commercial and operational consequences. Therefore, the vessel planner always has the last say, often resulting in a conflict with trade managers when containers were 'rolled over' by the planner due to stability reasons.

Vessel planners have the right understanding of the structure and pattern of the specific services that they plan. They are aware of the type of cargo lift in each port and, with this knowledge, reserve appropriate stowage space for future cargo from each port. Vessel planning has evolved as a process that is executed on a port-by-port basis, one port at a time.

What happens when a new planner takes over a particular service very different to the one that he has worked on earlier?

Ports of call are different and so is the design of the vessel type in this service. By having a digital record of each vessel and the details of cargo lift at each port, new planners have a platform that allows access to information and data that can enable consistency in safe and secure stowage planning.

In multi-partner services, more than one carrier operates within the VSA (Vessel Sharing Agreement), and the vessel's allocation is shared between these partners. Cargo forecasts in such VSAs prove to be a significant challenge given that each of the participating carriers provides their cargo forecasts for their part of the allocation. It is usually the vessel operator's agent or the port captain who consolidates these multiple forecasts to create a single load list. For small carriers, where vessels are not shared with partners, the challenge is to generate a reliable and detailed cargo forecast. What generally appear are average weights, few cargo details, and insufficient DG control, all of which create a high-risk scenario, lack of an optimized stowage, and consequently a low vessel utilization.

These forecasts generally come with details that are lacking, sent at different times, in different formats (EDI, excel, etc.) thereby, necessitating a laborious and time-consuming manual process of consolidation. The vessel planner, who receives the cargo forecast at the last minute, is tasked with generating a cargo plan with insufficient data in a short time span.

We've heard expressions of good intent such as "Best wishes", "Bon voyage", and "Break a leg." In the world of liner shipping, it has always been, "Full ships!"

This is a term that accompanies the wave of many a Sales lead to the sales team as they hit the market and try and maximize revenue and profits.

But then, what is a full ship?

In most cases, the cargo capacity of service is calculated in Twenty Equivalent Units (TEUs) based on 90% of the vessels' nominal capacity (excluding the High Cube factor from the equation to make it simple). This is an uncomplicated way to calibrate a vessel within the service, however looking at it commercially, an essential factor is the weight of the said TEU.

The vessel's capacity therefore is a mix of volume and weight. To calculate the volume, as mentioned earlier, we can assume a percentage of the nominal capacity, pretty simple and straight forward; the cargo deadweight is calculated based on the summer draft. Some services have further restrictions such as, draft zones and draft restricted ports, which ultimately put a cap on the maximum weight a vessel can load.

To optimize the vessel's intake, there must be a balance between the allocation in TEUs and the average weight of the cargo. However, what usually happens is that the commercial agent overbooks to cover any unpredictable shortfalls.

Today, a planner's plight is to perform multiple manual iterations in the stowage system to get a number that could be used by trade managers. The process is not only opaque to all stakeholders but also time-consuming.

One of the most important parameters to measure the successful outcome of efficient vessel planning is to reduce time in port — less time in port is 'money in the pocket'.

As an impact of spending less time in port, shipping companies can plan the voyage on economical speed, reduce bunker costs and add more ports in the service rotation.

Loading hazardous cargo on a vessel is an onerous task. Each dangerous cargo shipment must be loaded to satisfy constraints based on IMO (IMDG)rules, vessel construction, and in-house company rules, which require close inspection and validation by experts.

The risks involved are immense and we have many an example where a deviation or lapse has resulted not just in commercial losses but loss of human life and irreversible damage to the environment.

An event that results in cargo loss or damage generates a substantial financial impact on carriers and shippers, not to mention the environment. Some of the latest incidents led to financial losses of more than 200m USD as the legal process and claims take years to resolve. These events can result from a single event or a series of events, which were overlooked or downplayed during voyage planning.

A few of the common flaws include:

A lack of an optimized weight-mix during the cargo forecast process. Heavy containers loaded on the last port of a coastal rotation, give little or no chance to have an optimized weight distribution resulting in the stability criteria being compromised.

Insufficient weather and route planning for the sea passage.

Commercial pressures to cut corners or poor decision making.

Lack of proper stability and lashing calculation tools driving to a scenario where safety limits are exceeded during the voyage.

Insufficient communication and sharing of data between the vessel stowage center and the vessel's staff.

Mismatch in cargo loading plans between commercial and stowage teams

It has often been noticed that Trade Managers, Slot Controllers, and Liner Commercial Agents responsible for the acceptance of cargo to be loaded on a vessel, usually work with their own off-line databases. This typically results in assumptions being made that are far removed from reality in relation to the vessel's open cargo space, or prevailing cargo mix.

Allocation control is put to a challenge when there are continuous changes in allocation, space swap and sub-allocation between the partners. This is a

highly dynamic process and the only way these space controlling managers get up-to-date information is to wait for the departure BAPLIE file. They then load this information into spreadsheets, run ad-hoc reports, and distribute the results within their area.

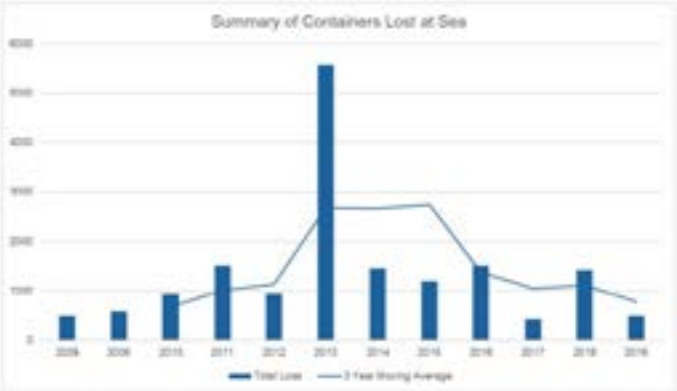
The commercial agent shares the cargo list with the vessel planner 24 hours prior to the vessel's arrival. Meanwhile, the terminal's expectation would be that the carrier provides the stowage plan at least 8 hours before operations commence, which enables them to have an optimal yard plan and sequence the loading pattern in the best possible way.

After receiving the cargo load list, the planner begins to work on the stowage plan, which takes on average about 2-4 hours depending upon the planner's experience and the number of containers to be loaded or discharged. The time spent during the stowage planning ascertains if all cargo fits perfectly and this

is done through manual allocation of containers into the charted bays. Furthermore, readjustments are made to allocate slots for refrigerated cargo, DG cargo, and other special containers that require special deployment. Upon completing this very manual task, there is little, or no time left to optimize stowage using the planner's skills.

EVIDENCES THAT REITERATE THE NECESSITY AND IMPORTANCE OF AN EFFICIENT STOWAGE PLAN.

According to a recent 12-year survey released by the World Shipping Council between 2 008 and 2019, it has been estimated that nearly 1,382 containers are lost at sea every year on an average.

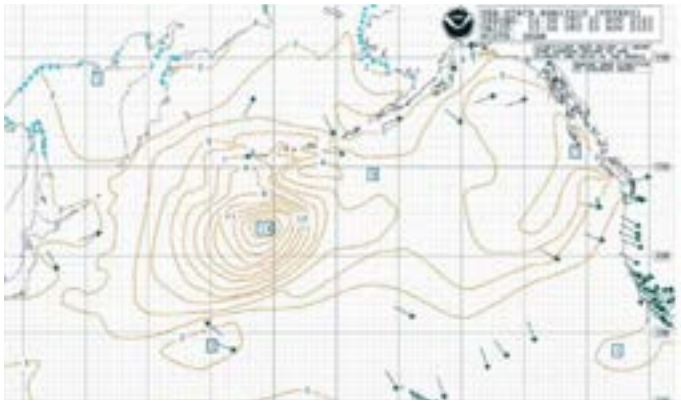


World Shipping Council

> *This is another prime example of why we must improve in this industry. A situation like this would give real-time information, allowing companies that are importing those containers to make quick decisions. And it's not only the execution management that digitization brings, but it's the exception management. Digitization would provide visibility to cargo lost overboard.*
>
> **– The Executive Director, Port of Los Angeles**

November 30, 2020

A Japanese-flagged vessel loaded with 14,000 TEUs, en route from Yantian, China, to the Long Beach, California, encountered severe storm conditions about 1,600 nautical miles from Hawaii and suffered a loss of approximately 1,800 containers. This incident, which is said to be the second biggest cargo loss ever in liner history, is a chilling reminder of the impact that weather can have on the safety of life and cargo at sea. Sixty- four of these lost containers bore dangerous goods markings.



A map shows 16-meter significant wave heights associated with the November 30, 2020 weather system

January 01, 2019

A Panamanian-flagged vessel, with a capacity of 19,224 TEUs, encountered sudden steep waves and strong tides while en route from Portugal to Bremerhaven, Germany. This vessel carried 13,466 TEUs, of which 2,659 were 20-foot and 5,403 were 40-foot containers. The North Sea is relatively shallow in this route and a storm-force northwesterly wind that generated high waves hit athwartships of the vessel. As the ship was forced to face extreme rolling movements, the containers began to slip into the sea, thereby leading to a loss of 342 containers that measured about 3,000 tons of cargo. The containers held items such as furniture, toys, electronic gadgets, toxic materials and lithium-ion batteries that were swept away towards the coastline of Wadden Islands. It took months for the Dutch army to clear the wreckage.

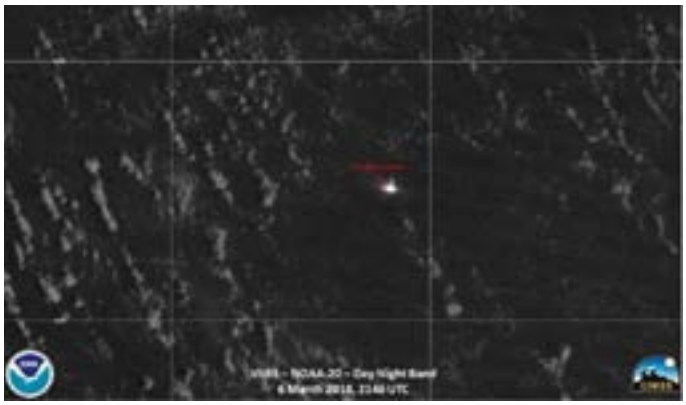
The most significant recommendations, as an outcome of the investigation, were for better stowage of the containers in order to enhance stability and improved lashing systems that would have increased the chances of risk-free transportation of the boxes.

March 06, 2018

The 353 meters Ultra-Large Container Ship (ULCS), with a capacity of 15,626 TEUs, was one of the very large vessels sailing across the globe in 2017. This vessel carried up to 7,860 containers, equivalent to 12,416 TEUs, and was en route from Singapore to Suez, Egypt. A severe fire broke out on board while the vessel was heading towards the west of the Arabian Sea, nearly 900 nautical miles away from the southeast of Salalah, Oman.

The flames were reported to be from the main deck, rising at about 25 meters off the ship's bridge. Despite containing the flames on board the vessel, the fire was so large that it could be seen from space at a certain point. The fire spread beyond control and the crew has to abandon ship. Of the twenty-seven crew members onboard, twenty-three were evacuated safely, while four crew members failed to survive the accident, and one remains missing.

This accident was tagged critical as lives were lost and cargo damaged.



A NOAA satellite captured this image of the vessel on fire from space, about 530 miles above Earth

We hope this investigation will initiate a more holistic, industry wide approach where we address the concerns regarding containerized dangerous goods across the entire supply chain – starting at the manufacturing level and following through until the box has been safely delivered at destination to the customer

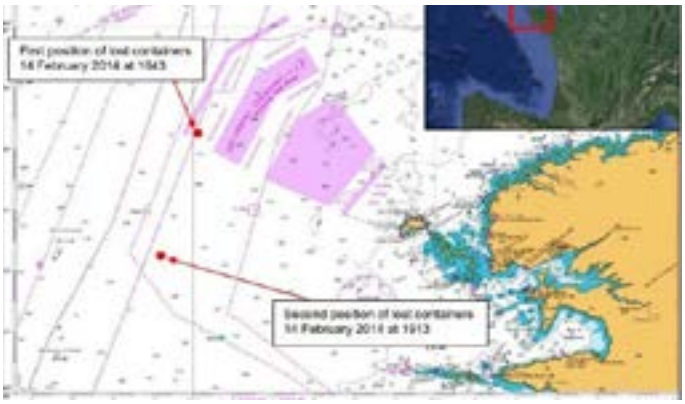
– The Chief Technical Officer

February 14, 2014

A 347-meter vessel with 8,160 TEUs on board that departed from Rotterdam encountered a similar situation. While sailing through the Bay of Biscay, the vessel unexpectedly experienced violent rolling twice on the same day due to extreme weather conditions that had intensified more than the forecasted predictions.

This resulted in a loss of 517 containers, damage of nearly 250 containers aboard, missing equipment and life-saving utilities fitted on the deck, and damaging of lashing gears for 600-700 containers.

This was stated to be an outcome of poor decision making due to lack of data during ambiguous circumstances with respect to unexpected climatic adversity.



Scene of the accident. Atlantic Ocean (Bay of Biscay) off Ushant Island.

Source: © Crown Copyright and/or database rights. Reproduced by permission of the Controller of Her Majesty's Stationary Office and the UK Hydrographic Office (www.ukho.gov.uk) & Google Earth.

June 17, 2013

The 8,000 TEU-type container vessel incident while en route from Singapore to Jeddah loaded with 7,401 TEUs has been recorded to be the most striking incident in history. The vessel suffered from a shattering hull girder fracture, developed a critical hog, and cracked into half at about 200 miles away from the Yemeni coast. Fortunately, all 26 crew members had a favorable situation to escape the accident while abandoning the sinking ship.

> *Despite the vessel's exceptional structural efficiency and design for long voyages and high waves, this incident was reported to be an outcome of an inefficient stowage plan.*

Prior to the incidents mentioned above, there are other historical events that highlight the need for the shipping industry to modernize its stowage planning protocols.

July 2012: A 6,732-TEU post-Panamax ship en route from the United States (South Carolina) to Belgium (Antwerp) suffered a series of explosions that led to four fatalities, cargo damage, and an environmental hazard caused by the release of toxic smoke.

January 2007: A 4,419-TEU containership en route from Antwerp to Sines experienced hull fracture due to heavy weather. It took 924 days for the salvage crew to accomplish the onerous recovery process.

March 21, 2006: A 5,550-TEU vessel was damaged by a powerful explosion that kept the fire active for many days leading to a loss of 1,000 of the total 3,000 containers.

November 11, 2002: One of the newest vessels en route from Singapore to Hamburg, Germany, had more than one container stuffed with fireworks. A massive second explosion, four days after an initial blast, had triggered the ignition of the fireworks. This accident was declared to be a total loss with zero salvage and two fatalities.

In conclusion, inadequate stowage planning spotlights significant safety concerns and poses a considerable risk to the stakeholders involved in the voyages. The impacts are intense that includes loss of cargo, environmental damage, and loss of life. Dangerous goods demand extra attention to avoid disasters occurring due to any unforeseen interactions of hazardous materials. In order to exclusively address safety concerns, the International Maritime Organization (IMO) developed IMDG, a wide range of international regulations that need to be adopted by all global shipping nations to enhance the safe carriage of dangerous goods and prevent the environment from being polluted. The IMDG code elaborates the detailed requirements applicable to every material involved in transferring DG cargo with specific reference to the segregation of incompatible materials. The Member Governments submit proposals on amendments every two years, and proposed changes take effect based on recommendations from the United Nations. Voyages planned by strict adoption of the IMDG standards are less prone to disasters.

AI TECHNOLOGY – THE KEY TO ELIMINATE LINER CARGO ACCIDENTS WITH EASY, EFFICIENT, AND SAFE STOWAGE PLANNING.

A unified cargo forecast planning platform that allows carriers to plan and formalize stowage through consolidated multi-format files, and share detailed information, most importantly, on time.

A tool that analyses cargo on board and generates a volume and weight-optimized cargo plan based on load projections. Algorithms perform calculations based on the current loading condition while maximizing the available space with the right container size and weight (best scenario), considering stack weight limits, visibility restrictions, stability limitations, hull stress, and lashing forces. Consequently, with vessel capacity having been optimized, cargo lift is enhanced, and hence, net profit increased. An historical analysis of the cargo mix for a specific service, leg, or season would be core to the algorithm to create the best possible cargo mix.

A centralized planning and stowage system that would enable:

- Better communication between the trade managers and stowage planners
- Planners to bridge the 'silos' in an organization through readily available and accessible information
- Highly reliable stability, DG segregation, and
- lashing calculations
- Live cargo forecast feeds and manage dynamic capacity control
- Elimination of manual processes while giving the planners ample time to optimize the vessel's intake and reduce the risk of catastrophic incidents.

Well-defined dashboards and reports that allow all stakeholders not only to access the planning tool information but share updated information such as changes in allocation, sub-partners, and vessel size, thereby enabling the organization access to the latest and most reliable information, allowing managers to make quick decisions based on reliable data.

SONATA: AUTOMATED STOWAGE PLANNING IN LESS THAN 30 MINUTES.

The benefits of an advanced technology-centric stowage planning solution that is compliant with hazardous cargo, stability, stress, and segregation rules

Solverminds is transforming the future of the maritime industry with best-in-class solutions. Having empowered decades of safe and successful sailing, SONATA is a digitally mutated stowage optimization solution that embraces advanced technologies that include predictive analytics, integrated ERP, machine learning, and high-level optimization algorithms.

As a unified interactive planning solution, SONATA delivers a stowage planning experience that is fully automated – end-to-end. It offers real-time visibility of container data, stability, and strength calculations, lashing conditions, and cargo forecasts.

SONATA embeds best practices, which ensure effective management of constraints such as stack weights, lashing limits, container size, vessel stability, trim

and ballast that may contribute to the risk of losing containers at sea. It is a unique solution that allows striking a perfect balance between performing multi-port planning, round voyage analysis, and cargo feasibility checks on one hand and factors that affect optimality on the other.

ABOUT SOLVERMINDS

Established in 2003, Solverminds is a leading next-gen global technology company with a vision to empower businesses with innovations reimagined. Our exceptional domain expertise and cutting-edge technology solutions offer a complete range of best-in-class products for liner operations management, ship management, agency management, and advanced analytics.

While our technological focus is on delivering reliable, resilient, and robust solutions that embrace Artificial Intelligence (AI), Machine Learning (ML), Predictive Analytics, and Big Data, our strategic focus remains on quality and customer-centric approach, research and developments, and thought leadership.

Solverminds is a smart and sophisticated technology provider of a wide range of solutions and services that enfolds integrated and bespoke ERP, global consulting, cloud system, and advanced analytics. We help you ascend the ridges of the extremely competitive current world by automating your business processes while offering actionable insights, predictive outcomes, and optimized solutions to make in- formed decisions.

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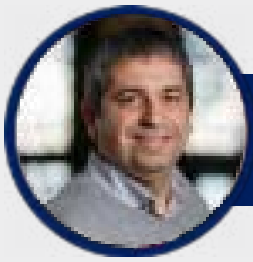

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