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LASH FIRE

Deliverable D08.7
Description of stowage plan visualization aid demonstration
August 2023

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Abstract

As part of the Lash Fire project, a fire hazard optimisation tool was developed, to prevent or limit the effect of ignition through focus on the stowage planning process. The tool utilises a fire hazard management algorithm to calculate and reduce fire risks based on individual cargo units and their relative deck positions.

The demonstration described in this report focuses on the demonstration of the interactive prototype showcasing the proposed fire hazard optimisation tool. The testing protocol involved task completion, such as retrieving fire hazard ratings, and use of the fire hazard management feature. Participants were asked to provide 'think-aloud' commentary during the process. The sessions also included follow-up questions to gather in-depth insights on tool usage, experience, and potential areas for improvement.

Results from the demonstration showed an overall positive response to the tool's functionalities. Participants appreciated the integration of fire hazard ratings and fire hazard management into the stowage planning process and reported that the tool may be a way to raise awareness of cargo-related fire hazards, and importantly, to save valuable time when responding to a potential fire incident. The participants reported high satisfaction levels, and potential efficiency gains. Notably, the visibility and understanding of fire hazard ratings were recognised as useful, as well as efficiency gains by ease of access to detailed cargo information, which is important for monitoring fire hazards and for responding to a fire. Another potential efficiency gain is the possibility to monitor the loading process, as the prototype integrates information which is currently often distributed across various systems.

However, participants also highlighted areas for potential improvements. This showed that the information about the fire risk reduction results could be further refined for better comprehension. Another example of feedback was the expectation among users that they should be able to easily make manual adjustments to an alternative stowage plan if necessary, and to customize the contents of the tables presenting cargo information. There was appreciation of a tool which would integrate information and functions which are currently distributed across several systems but also done manually on paper. This also led to discussion about the expected difficulty of integrating the tool with existing cargo management systems. Another central point of discussion was the challenge of different planning and loading practices depending on the organisation of port terminals, and turnaround time in port.

In conclusion, the prototype of the user interface for the tool was positively received and demonstrated promise in enhancing safety measures during the RoRo ferry stowage planning and loading processes.

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1   Executive summary

1.1   Problem definition

Addressing cargo-related fire hazards during planning and stowage presents several challenges. At present, the management of potential risks is concentrated on cargo identified as dangerous goods, according to guidelines such as the "Accord européen relatif au transport international des marchandises Dangereuses par Route" (ADR) and the "International Maritime Dangerous Goods Code" (IMDG). However, there are gains to be made, particularly in terms of ignition prevention, by considering the potential hazards posed by other types of cargo, as per the historical data found in reports for the last 25 years as well as new trends as the increase of the EV fleet and by identifying hazards related to vehicles.

The objective of Action A in WP8 was to develop a comprehensive stowage planning tool that increases fire safety. The proposed solution comprises a Vehicle Hotspot Detection (VHD) system and a software component which utilizes historical data to assign a risk score to each cargo unit. Guided by these risk scores, the system can strategically place cargo units to minimize overall fire risk. This strategy not only mitigates fire risks but also enhances the accuracy of cargo information, which can support an effective response in potential fire incidents.

While safety measures often entail additional costs, the potential benefits, such as reducing overall fire risk through improved cargo distribution, are considerable. By implementing these improvements, the aim is to significantly reduce the risk of fires in ro-ro spaces.

1.2   Method

The main objective of this report is to summarise the demonstration conducted to illustrate the functionality of the Stowage Planning Tool (SPT) for potential users through two interactive prototypes. The SPT prototype is comprised of two mock-ups crafted using Figma and Axure prototyping tools, based on the requirements delineated in deliverable D08.3 "Development of fire hazard mapping visualization tool with fire hazard matching integrated," and detailed in D08.4 *"Stowage planning optimization and visualization aid ".* The report describes the structure and frequent components of the GUI, both for the desktop version, which is designed for stowage planning, and the tablet prototype designated for use during the loading procedure.

The graphical user interface (GUI) follows the OpenBridge Design Guideline [1], which establishes a generic user interface layout and repeat elements. The design has evolved based on user feedback and heuristic evaluation of an earlier version of the GUI, in February 2023.

The design conforms to ISO 9241-210 [2] emphasizing end-user participation in design and assessment processes. This demonstration aimed to illustrate the SPT's utility, ease of use, and intuitiveness by involving ship and terminal operators.

These tasks in the demonstration were based on prioritised use cases (UC) described in D08.4, addressing specific aspects of the SPT, an approach for ensuring the tool meets user needs and expectations in different scenarios and contexts-of-use. Additional details about the visualisation requirements and the Human Centred Design process (HCD) can also be found in deliverable D08.4. The Hotspot Detection system is thoroughly described in D08.9 "Prototyping and demonstration of vehicle identification tool," and the technical solution for cargo hazard information based on historical data, and the cargo distribution algorithm is described in D08.9 – Prototyping and demonstration of vehicle identification tool.

1.3   Results and achievements

Today, the loading process of ro-ro ships leaves room for improving the stowage process from a fire safety perspective. While dangerous goods are handled with the care and attention, other cargo units are often stowed without consideration of the fire risks they may pose. Deliverable D08.04 'Stowage planning optimization and visualization aid' describes the development of a software

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implementing features that provide fire management considerations to the stowage process. Another objective was to develop a graphical user interface (GUI) for a stowage planning tool that includes these fire management features, and this document describes the demonstration of this user interface.

The approach involved creating mock-ups of the user interface which includes the risk assessment features into the stowage and loading process. The design was informed by conversations with LASH FIRE partners, field studies, and other data gathering, such as desktop research investigating standards, procedures, and similar types of systems.

The interface displays the risk scores based on historical data and offers placement recommendations to reduce the overall fire hazard. The user interface was developed using a Human-Centred Design (HCD) approach, involving end-users in the design and test cycles of the product development. The aim was to create a tool that is effective, efficient, and provides satisfaction to its users. The proposed design offers a more managed stowage process and more accurate cargo information, which not only helps prevent fire but also is useful in the event of a fire, for example by providing specific information to support path planning of the AGVs that have been tested to patrol the cargo space during the voyage.

The demonstration of the stowage planning tool, including fire hazard management, showed positive results. Participants conducted tasks such as generating fire hazard ratings for a stowage plan and using the tool to create an alternative stowage plan. The participants were able to successfully navigate the user interface and complete the tasks during the demonstration. In short, the participants found the stowage planning tool to be effective, as it could support both understanding and mitigation of fire hazards in their respective work settings. The visualisation of fire hazards and of the stowage process was also seen as ways to improve efficiency, not only in normal operations but especially in the case of a fire.

However, the demonstration also highlighted potential challenges of this type of system, due to varying user needs depending on the differing types of ro-ro operations. Quick port turnarounds, for example, can be a potential obstacle to the detailed stowage planning that the use of the tool requires: vehicles driven on board by their owners do not allow the same level of control over stowage planning as when professional tug-driver load trailers on ro-ro ferries. The variability in work organization regarding stowage planning, terminal operations, and cargo loading, present challenges in developing a GUI for a stowage planning tool that can effectively accommodate all scenarios. Another potential barrier might be that cargo owners might be reluctant to share detailed information about their shipments, due to fears of data leaks which can lead to vulnerability as specific types of cargo can be targeted by criminals. his is also a barrier to developing more sophisticated algorithms for cargo distribution as detailed in the conclusions of D08.4

However, the SPT was overall seen a promising way towards effective fire hazard management and efficiency. The tool can also be seen as important component for the 'Digital Fire Central' (D07.5 "Alarm system interface

Prototype"), as it provides a necessary path towards providing accurate, up-to-date cargo stowage information which is crucial for firefighting management in the event of a fire in the roro-space. The feedback and insights gathered from this demonstration can lay the ground for refining the user interface in further development, where accommodations be made for varying operational realities and the necessary high data security. While participants in the demonstration appreciated the fire hazard management features and found the tool useful, they suggested adding more transparency about how fire hazard ratings are calculated and ensuring that the tool's adherence to safety regulations is clearly communicated. This may be central for enhancing user trust and adoption of this type of tool.

2   List of symbols and abbreviations

ADR Route	Accord européen relatif au transport international des marchandises Dangereuses par Route
GUI	Graphical User Interface
HCD	Human Centred Design process
HUD	Head-up display
IMDG	International Maritime Dangerous Goods Code
RoPax	Combined Roll On- Roll Off cargo ship and Passenger ship
RoRo	Roll On -Roll Off cargo ship
SPT	Stowage Planning Tool
UC	Use Case
VHD	Vehicle Hotspot Detection

3   Introduction

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The stowage planning tool (SPT) is a mean to decrease fire hazard on Roro ferries through risk-based loading plan improvement - the Fire hazard matching tool - and a visualization aid that shows the results of running the tool, and cargo status in real time. The SPT is a proactive measure for fire safety, which enables fire risk reduction of cargo stowage, and is also a path towards providing accurate, up-to-date cargo stowage information to the 'Digital Fire Central' D7.5 "Alarm system interface prototype", as a means to support firefighting management in the event of a fire in the roro-space.

The background for the design of the Stowage Plan Tool (SPT), which identifies potential risks associated to a current loading plan and manages the distribution of cargo according to a set of rules designed to reduce fire hazards, has been thoroughly discussed in D08.4 'Stowage planning optimization and visualization aid', including the design considerations and the design and development processes. The focus of this report is on the demonstration of two SPT prototypes: a desk-top prototype for the planning process, and a tablet prototype to be used during the loading process.

The interactive graphical user interfaces (GUI) are crafted in the prototyping tools Figma and Axure and designed in accordance OpenBridge Design Guideline [1], which provides a generic user interface layout and recurring components. The term prototype is used interchangeably with the word mock-up, referring to the simulated GUIs designed in Figma and Axure.

The following section is a summary of the work performed in action A of work package 8 after which follow a description of the two prototypes included in the demonstration, and an outline of the demonstration itself.

3.1   Overview of action 8-A

Action 8-A's overarching focus was on facilitating the screening and management of cargo fire hazards, work which included the consolidation of regulatory, operational, and terminal requirements for a cargo fire hazard screening and management solution, and the development of a database of cargo fire hazards.

Subsequent tasks focused on the assessment and development of technology solutions: assessment of automatic and manual cargo identification screening possibilities, and evaluation of sensor possibilities for fire ignition prevention (D8.1). This laid the ground for developing a fire hazard matching and mapping tool and a software to integrate data feeds from these identification technologies (D8.2 and D8.3)

D8.4 describes the stowage planning optimization tool and a visualization aid based on cargo hazards and loading regulations. This tool incorporates a Human-centred design, ensuring intuitive and easy-to-use interactive stowage plans accessible from different points in the operation chain.

D8.9, D8.10 and D8.11 describe the solutions for vehicle identification and detection of potential ignition sources, and demonstrations of the solution.

The prototypes that were demonstrated for the purpose of this report, are a product of previous work on user requirements from which an interactive visualization aid was developed (described in D8.3) and from which the user interaction and functionality has been further developed in additional iterations of the Human-centred design process. All the details and functionality included in the prototype described in D8.3 were not replicated in the prototypes which are detailed in this report. Instead, the latest work has focused on the workflows for a tablet version for deck crew and tug-drivers, the presentation of results of the fire hazards management, and on how information be

presented in real time, to multiple parties, if changes are made to the stowage plan during loading, e.g., due to the screening process.

Creating a fully interactive mock-up/prototype of the entire stowage planning tool was not the objective, for several reasons. The focus has been on establishing a conceptual design before advancing to a high-fidelity, fully interactive prototype. Additionally, the wide array of user needs, influenced by varying time constraints and the diverse nature of vehicles loaded on the various types of RoRo ferries, and the organisation of work among different operators on land and sea, adds several additional layers of complexity. Each user type will have unique requirements depending on their specific context, which naturally complicates the creation of a universally applicable prototype. Given these varying needs, an ideal GUI would be one that adapts to the needs of different user types and their organisation. Creating such a dynamic, adaptable interface within a prototype is a time-consuming task and would be difficult to achieve with acceptable performance on platforms such as Axure and Figma. In addition, the objective of the research project was to assess certain aspects rather than to develop a fully functional software.

Hence, the focus is on the conceptual design of a flexible and effective tool that can cater to a wide range of scenarios and users, detailing sections relevant for the most important feature of the Fire hazard matching tool – visualising the results of the ratings and the changes suggested by the software.

4   Description of the prototypes

4.1   Desk-top prototype for the planning process

This section details the GUI that supports use of the SPT during stowage planning, which is designed for desk-top use. The main pages detailed in the prototypes were:

- login page
- select vessel/departure page.
- dashboard/overview page, showing fire hazard ratings, summary information about the cargo on each deck and loading information,
- deck page, showing fire hazard ratings, deck layout and cargo placement that respective deck.

The dashboard page provides controls for a planner to create/generate an alternative cargo distribution with a lower risk score, or to first rate the plan, if there is a preference to first make manual adjustments. The option to first get ratings on individual cargo units, can be a useful support if a planner prefers to make a stowage plan manually. The dashboard page presents the user with a visualisation of each deck as well as a table with details about each cargo unit, a table which can be filtered and sorted. The dashboard page also clearly displays fire hazard ratings as well as loading progress. The deck pages have a similar layout as the dashboard page but show a larger representation of each deck. Each page type is illustrated below, along with a short description. The login page shows points of entry for different users.
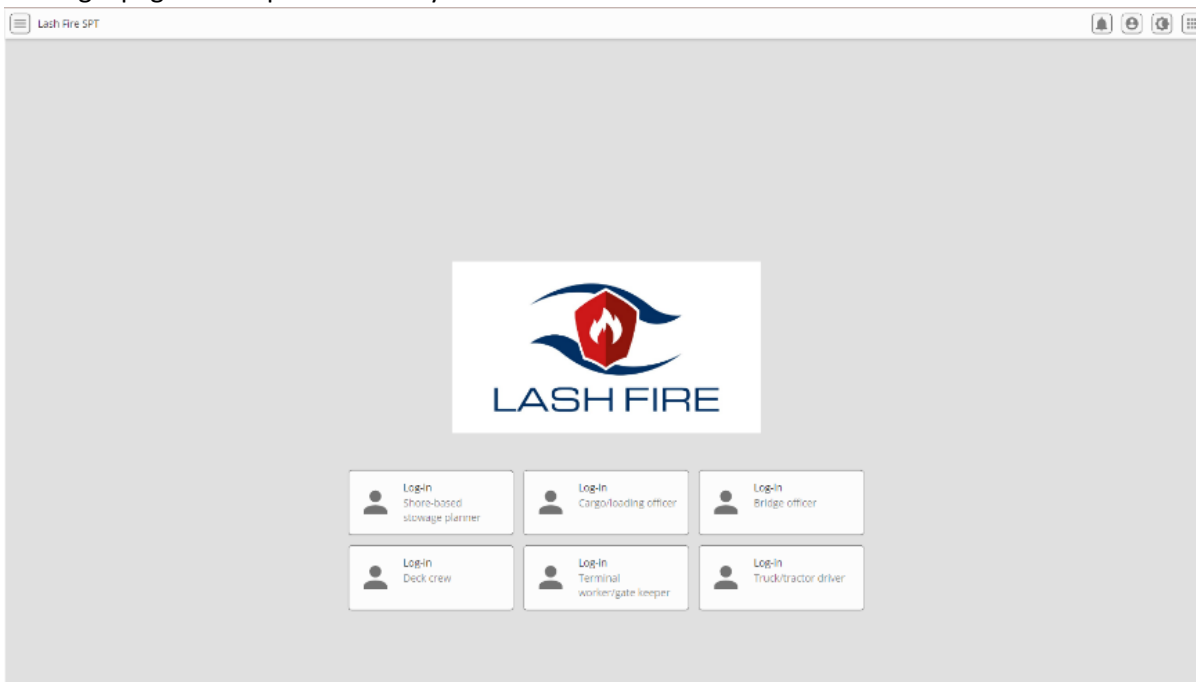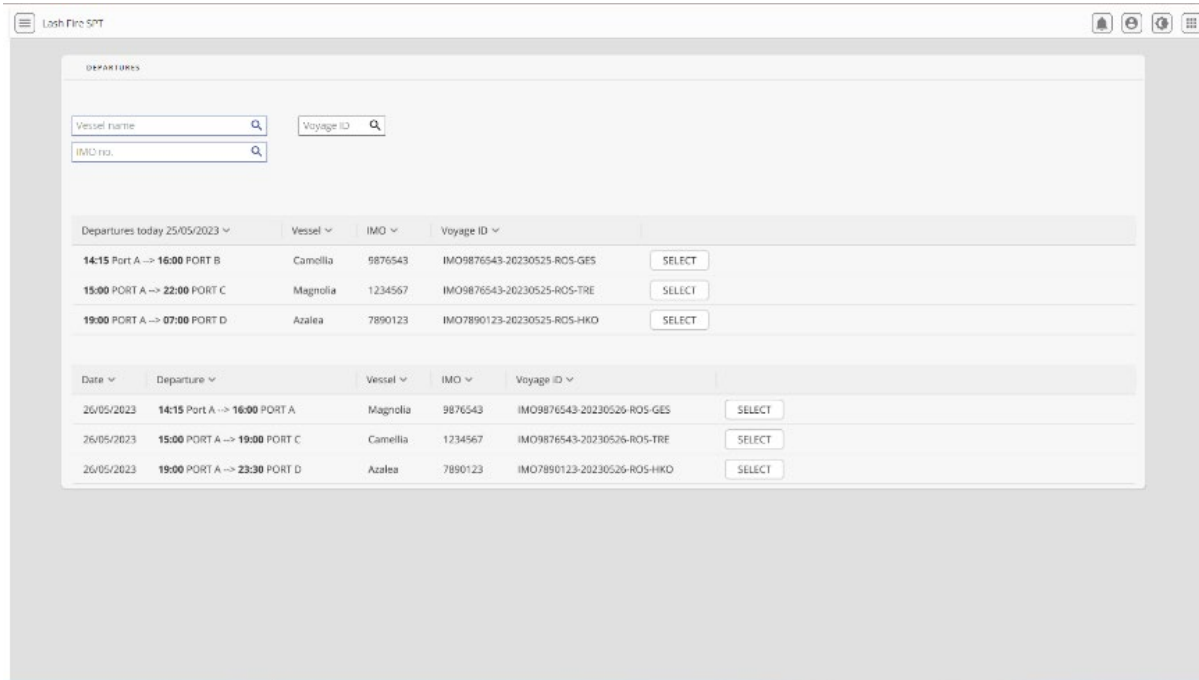

Figure 1 Log-in page

Figure 2 Overview page

4.2   Dashboard/overview page

The "Overview page" is designed in a way which allows the alert level to be quickly seen and provides the user with a summary of the ship's cargo and an overall fire risk score. This corresponds to the dashboard page and related use cases described in D08.3.
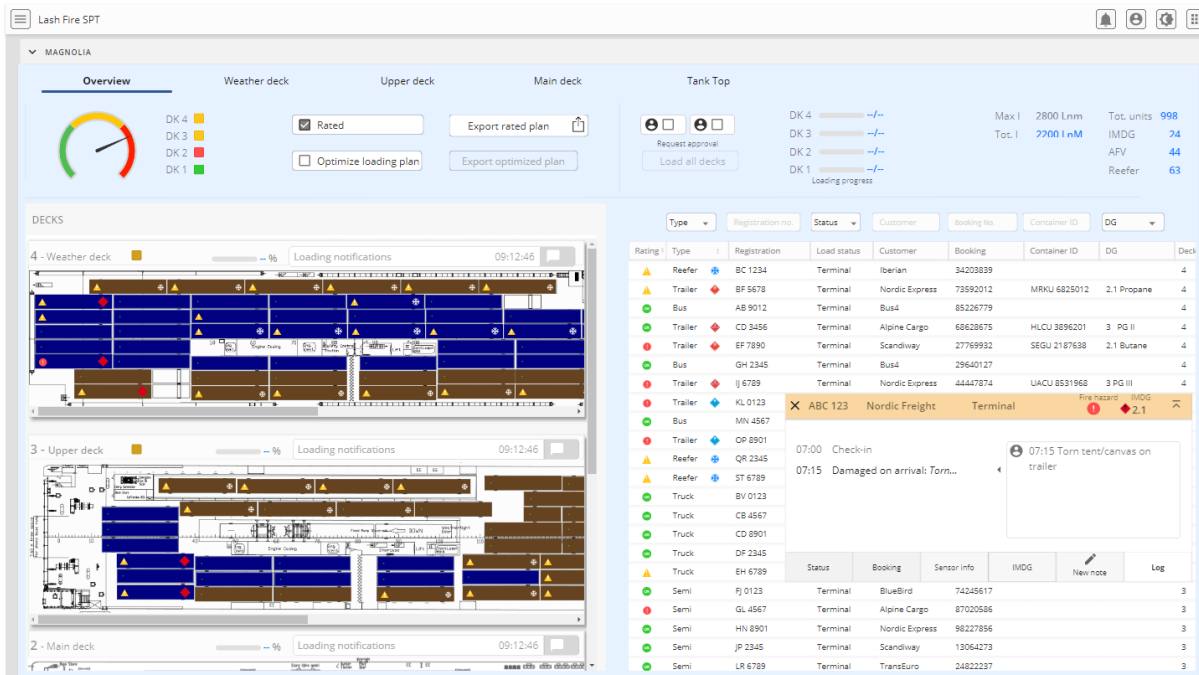

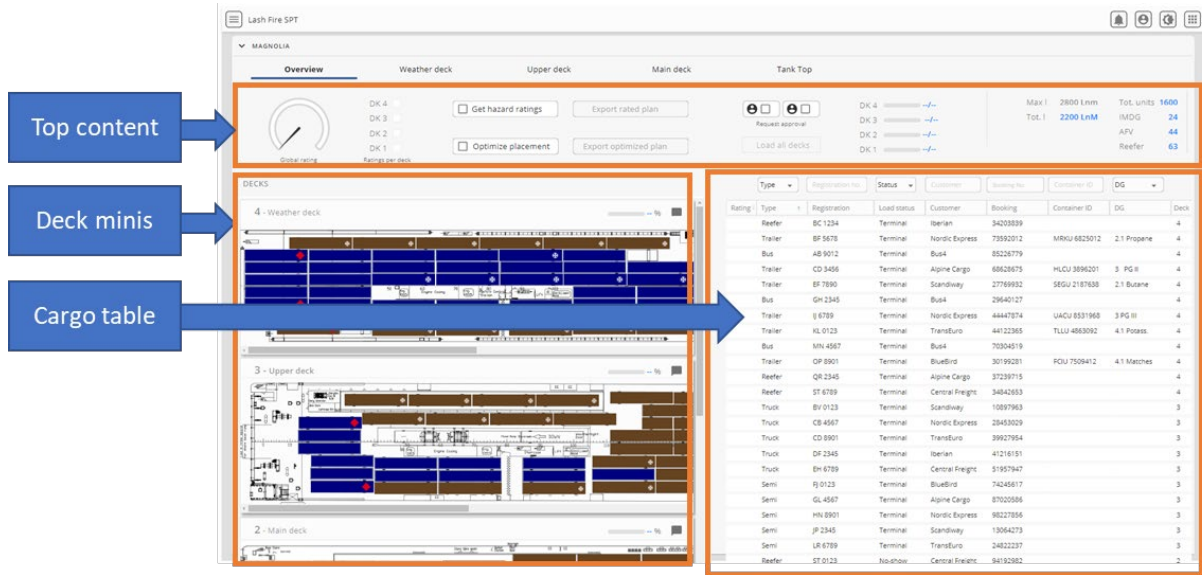
Figure 3 Dashboard/overview page

Figure 4 Dashboard/overview page, details

The dashboard page is designed to accommodate the needs of the **normal user,** who will be able to perform read operations and will not be able to modify any data, as well as a planner or cargo officer will gain access to the functions, they are authorized for through function buttons, displayed in the top content panel. The content of the top content panel (figure 4) information is described below.
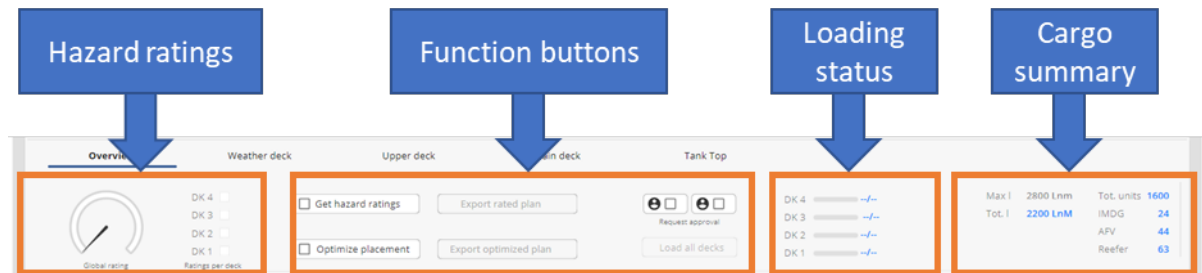

Figure 5 Top content panel on the dashboard page

Table 1 Details of the top content pane on the dashboard page

Figure 6 The fire hazard ratings	**Hazard ratings**: the results of the risk screening are presented with a radial dial for the global score as well as indicators of the risk level of each deck (*D08.3 #8: The system shall provide the user with the visualization of the overall risk level of the ship's cargo).* The design of the ratings follows the design described in D08.3.
Figure 7 Function buttons for hazard ratings and optimisation	**Function buttons**: these provide the necessary functionality for using the hazard rating and cargo distribution algorithm, and exporting and/or sharing the results.

DK 4 ▬▬▬ --/-- DK 3 ▬▬▬ --/-- DK 2 ▬▬▬ --/-- DK 1 ▬▬▬ --/-- *Figure 8 Loading status*	**Loading status:** an indicator of how loading is progressing for each deck (D08.3 #14: The system shall offer in real status the % of the loading process)

Max l 2800 Lnm   Tot. units 1600
Tot. l 2200 LnM   IMDG   24
                      AFV   44
                      Reefer   63
 	
Figure 9 Cargo summary
	Cargo summary: the total planned length and number of cargo units, and the number of units that are of extra interest from a fire hazard perspective (DG, alternative fuel vehicles, refrigerated units and other cargo/vehicles with increased fire hazards).

4.2.1   Deck page

D08.3 describes a page showing the load on each deck, how it is distributed, and the associated fire risk, using a colour map. In the GUI design, the proposed deck pages can be accessed from the tabs on the top row of the dashboard page. The deck pages have a layout which echoes the dashboard, but they show the expanded deck layout with cargo placement and a cargo summary and cargo list for that deck.

The deck maps show the general arrangement of each deck, including lanes and slots (*D08.3 #12: The system shall offer the user the possibility to display deck plans of all the predefined vessels).* Slots are numbered according to the last-in-first-out (LIFO) principle, as suggested in D08.3. When cargo has been planned and/or loaded, the cargo unit will be shown graphically on the deck map, with colours indicating risk levels.

The cargo icons on the deck map serve to provide a clear visual representation of the cargo type, differentiating between trucks and containers/trailers, with special indication of dangerous goods, and reefer units. Alternative fuel vehicle can be represented in a similar fashion. Once the cargo distribution algorithm has been run, a rating symbol on each cargo icon will indicate the fire hazard rating (*D08.3 #18: The system shall visually identify dangerous goods from other non-dangerous goods by colour coding).*

Once the cargo is rated by using the fire hazard rating and cargo distribution algorithm, each cargo unit will have an icon representing its hazard rating.

4.2.2 Hazard ratings and cargo distribution algorithm
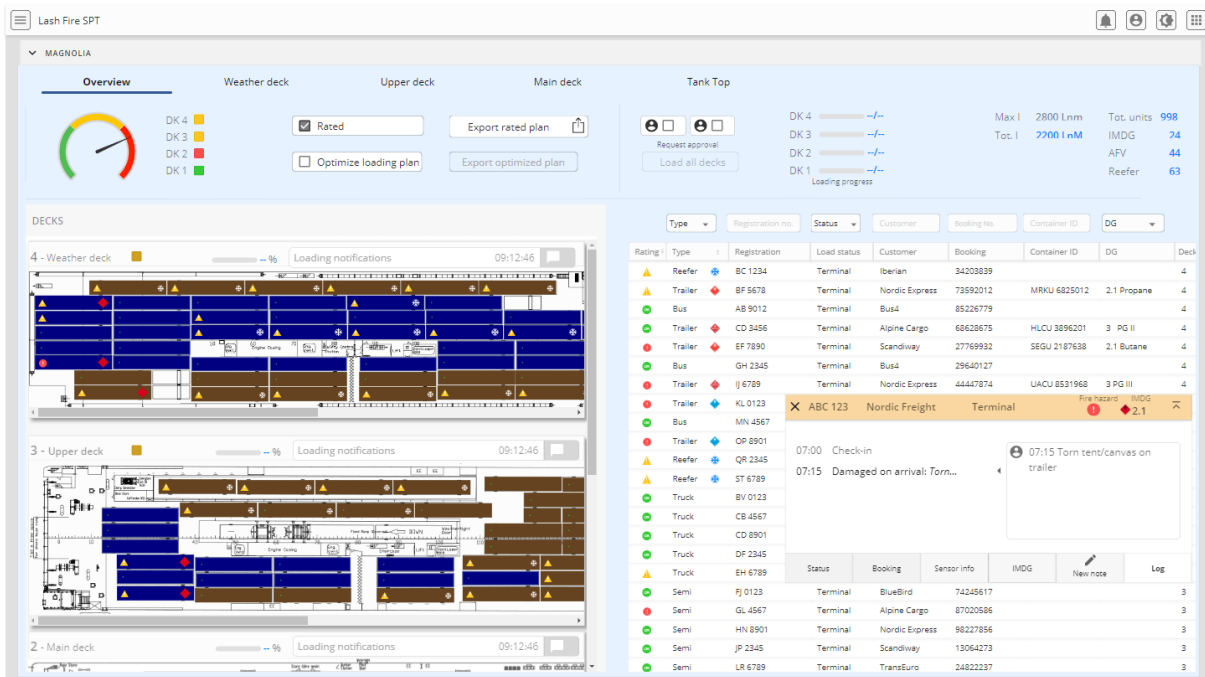

Figure 10 Vessel overview with hazard ratings

Hazard ratings are shown in several different ways. The radial dial on the overview page shows the total rating of the entire vessel, while the icons to the right of the radial dial show the rating for each individual deck. Hazard ratings for each individual unit are also shown in the first column of the cargo table (figure 10). Cargo distribution results are similarly shown by a radial dial as well as ratings for each individual deck.

Once a plan has been rated and/or cargo has be distributed according to the algorithm results, there will be an option to export the plan. Buttons to request approval for the stowage plan enable sharing the plan with relevant actors (figure 11)
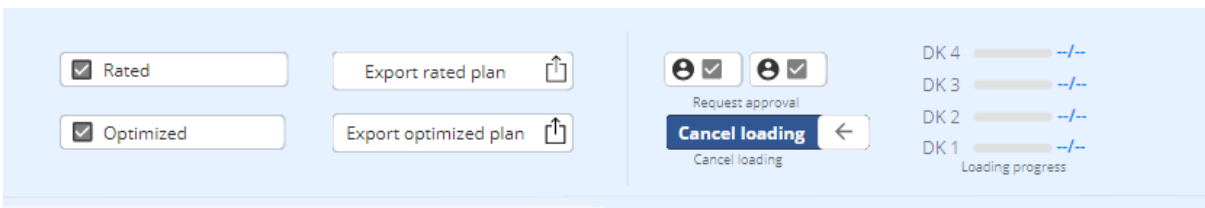

Figure 11 Export plan and/or request approval for a stowage plan

4.2.3 Cargo table

The cargo table (figure 12) is a sortable table that corresponds to "Detailed summary according to vehicle" in D08.3.

Rating	Type		Registration	Load status	Customer	Booking	Container ID	DG	Deck
⚠	Reefer	❄	BC 1234	Terminal	Iberian	34203839			4
⚠	Trailer	◆	BF 5678	Terminal	Nordic Express	73592012	MRKU 6825012	2.1 Propane	4
✅	Bus		AB 9012	Terminal	Bus4	85226779			4
✅	Trailer	◆	CD 3456	Terminal	Alpine Cargo	68628675	HLCU 3896201	3 PG II	4
⛔	Trailer	◆	EF 7890	Terminal	Scandiway	27769932	SEGU 2187638	2.1 Butane	4
✅	Bus		GH 2345	Terminal	Bus4	29640127			4

Figure 12 Cargo table

Generated hazard ratings for each cargo unit are displayed in the ratings column on the far left.

Each column can be sorted, and there is also the option to filter or search each column, e.g., by booking number or by registration number (*D08.3 #24: The system shall allow searches within the loads).*

Dangerous cargo is indicated by standard IMDG symbols (D08.3#17. The system shall visually identify dangerous goods from other non-dangerous goods by colour coding), and risky cargo such as reefers are indicated by icons. The individual risk level of a cargo unit is shown by colour coding when the rating algorithm has been run.
In the SPT UI prototype, additional information is included to support the planning process and to provide information that is relevant for firefighting, e.g.:

- UN number
- Check-in status/terminal position
- Trailer number
- Customer name (important for visual identification of cargo units)
- Plug-in temperature
- Number of drivers and passengers (important information in the event of a fire)

Additional information about each cargo unit can be provided by adding columns to the cargo table. Clicking on a cargo unit on the deck layout will display the cargo unit's registration number and the relevant row in the cargo table, or vice versa.
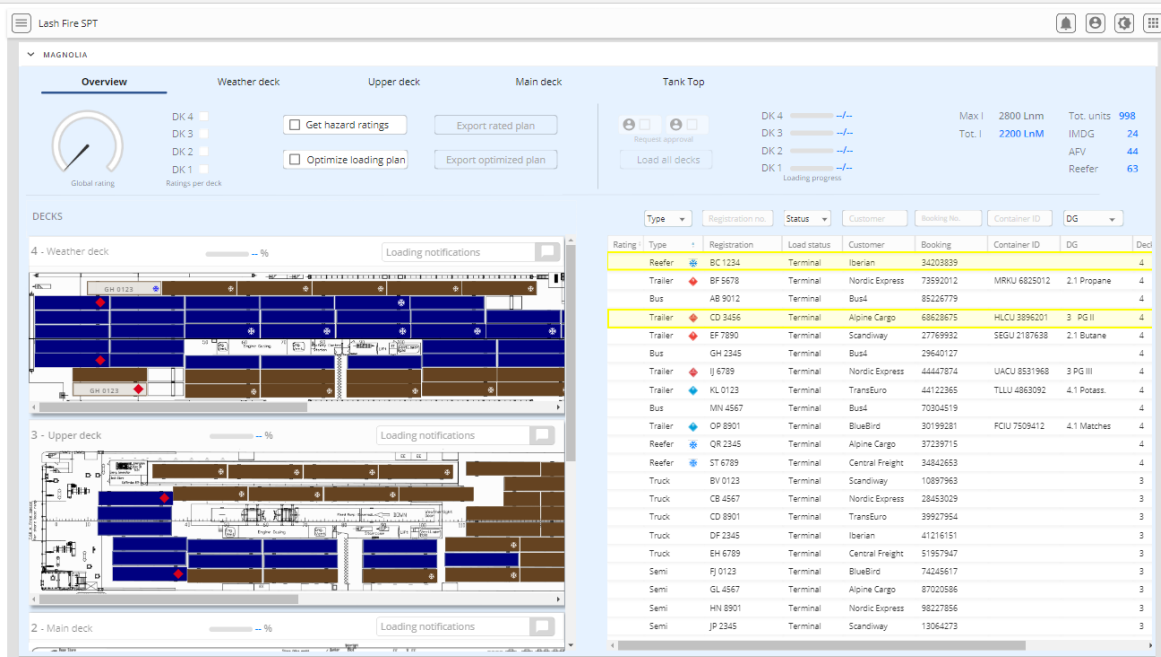

Figure 13 Clicking on a cargo unit on the deck layout will show the units registration number and highlight the relevant row in the table, or vice versa.

4.2.4   Cargo card

The cargo card is an element which is intended to be common for all user types. A shared common representation of important information is a way to support shared understanding across an organisation, and different professional roles. The cargo card is designed to be an efficient way to display a cargo unit's associated information, which is derived from the cargo manifest, load sensing and observations. The design answers to detailed requirements from D08.3:

- D08.3 #2: The system will provide the user with information on the selected load unit.
- D08.3 #4: The system shall always offer the visualization of the status of the cargo unit.
- D08.3 #6: The system shall offer the user the visualization of a unit load and its individual risk level.
- D08.3 #10: The system shall provide cargo location safety recommendations for each cargo unit.
- D08.3 #15: The system shall offer users the possibility to do manual annotations on each loading unit.
- D08.3 #20: The system shall allow marking of the unit load being loaded and unloaded.
- D08.3 #22: The system must be able to display information of a cargo unit in such a way that all users can identify the cargo.
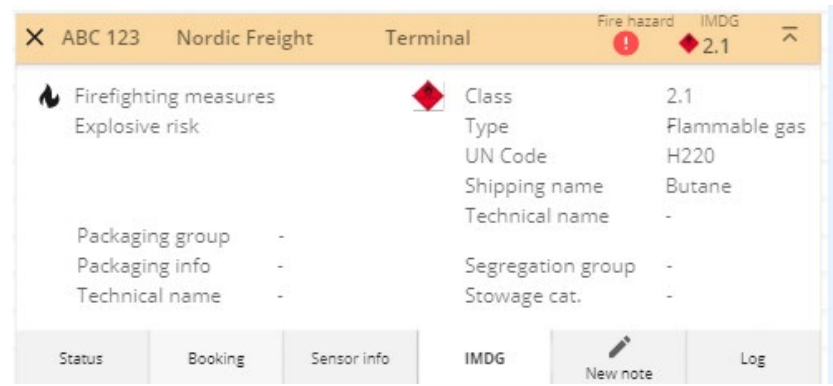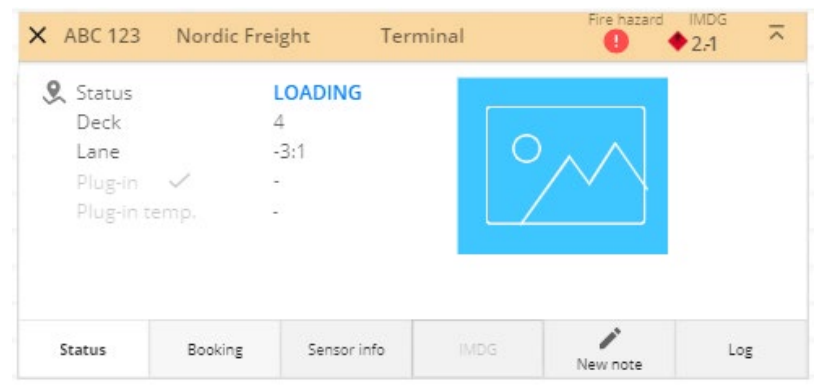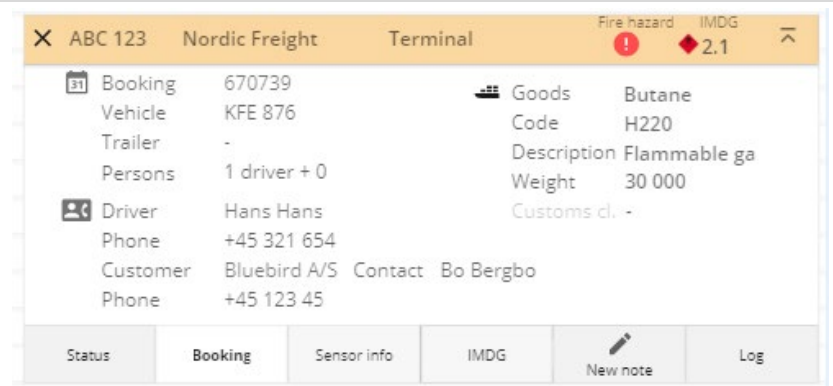
For a planner for example, the "cargo card" will be accessible as a pop-up, accessed by clicking on a row of the table to show detailed information, e.g., cargo location safety recommendations (*D08.3#9. The system shall provide cargo location safety recommendations for each cargo unit.)* The cargo card is way to gather detailed information about each cargo unit, and to present this information in a consistent manner to all users. It gathers all accessible information about a cargo unit and cargo type, e.g.

- Booking and cargo details
- dangerous goods information

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- automatic logged information about check-in, VHD results, and loading progress.
- hazard rating
- manual annotations made by crew during loading and stowage, e.g., about the condition of cargo (e.g., damage incurred during loading/unloading).

Table 2 (below) displays the contents on the various tabs of the cargo card.

 Figure 14 Cargo card: Dangerous goods tab	DG tab: special information related to dangerous or flammable goods. Here salient information for firefighting, to e.g., support decisions about drencher activation, or information about the risk of toxic gases can be displayed.
 Figure 15 Cargo card: Status tab	Status: information related to loading - if the cargo unit is checked in and is waiting in the terminal, and the various phases of loading are shown here.
 Figure 16 Cargo card: Booking tab	Booking: details about the booking and the customer, e.g. contact details to the driver and the number of passengers. This information may be of importance during a fire incident.

Figure 17 Cargo card: Sensor info tab

Sensor info: results from the VHD scanning are shown here.

Figure 18 Cargo Card: Annotations tab

New note: here the user can enter necessary annotations, for example about damage to the cargo, which is important for liability during cargo transports.

Figure 19 Cargo card: Log tab

Log: here status and annotations related to the cargo unit are displayed in an accessible way, to give a quick and updated presentation about a cargo unit.

Table 2 Details of the "cargo card"

4.3   Tablet prototype for the loading process

This section details the GUI designed for a tablet format, which supports use of the SPT during the loading process, by tug-drivers and by crew involved in loading.

One workflow is designed for tug-drivers, and one for deck crew during loading.

4.3.1   Tug-driver GUI

This section shows how the proposed design can support a potential workflow for a tug driver. This workflow encompasses the steps of picking up a cargo unit, marking any visible damage, driving through the Vehicle Hotspot Detector (VHD), and requesting a new loading spot.

The two main types of views are a cargo table, similar to the cargo tables described in the previous sections, and a work-flow view featuring two key areas: the top portion displays information about a specific cargo unit, while the remaining screen space outlines the guided task sequence, providing step-by-step instructions for the tug driver's workflow. Figure 19 shows the steps of the guided task sequence, where the current step is highlighted and completed steps are indicated with a checkmark. The first step is at the bottom.
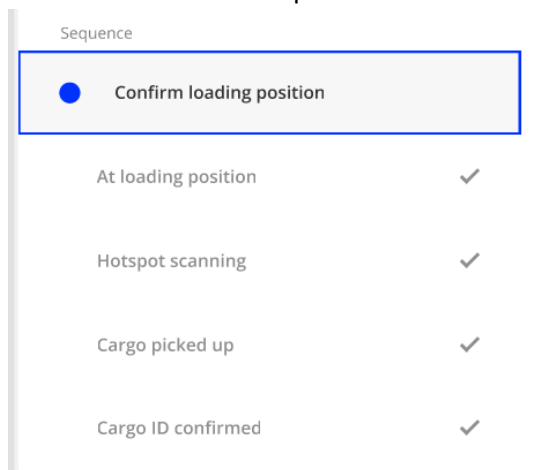

Figure 20 The steps of the guided task sequence for the tug-driver

Table 5 below shows the workflow in screenshots of the mock-up, with short descriptions.
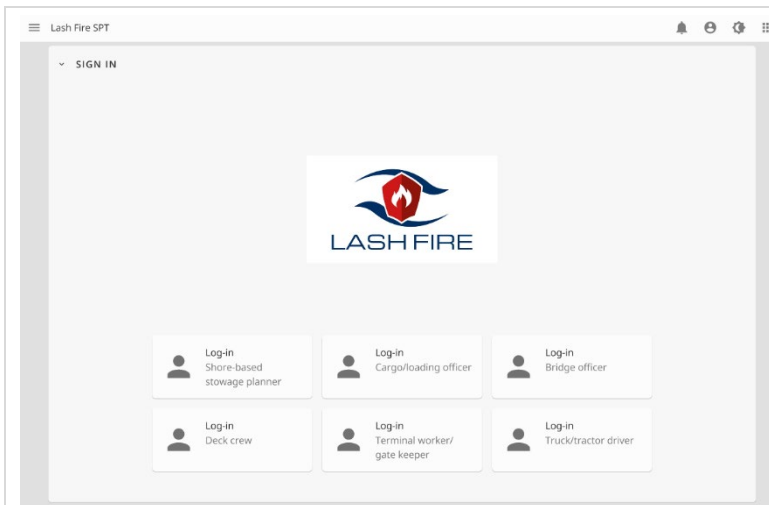*Table 3 Table showing the workflow for the tug-driver.*
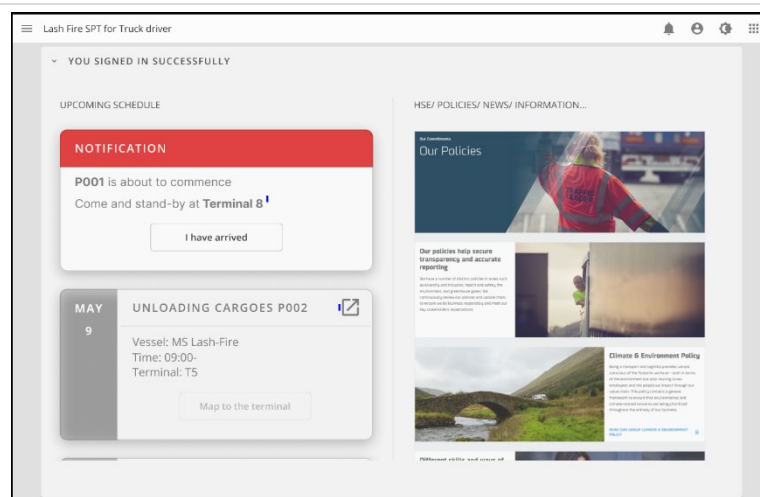

Figure 21 Log-in page

The tug-driver logs in.

Figure 22 Landing page

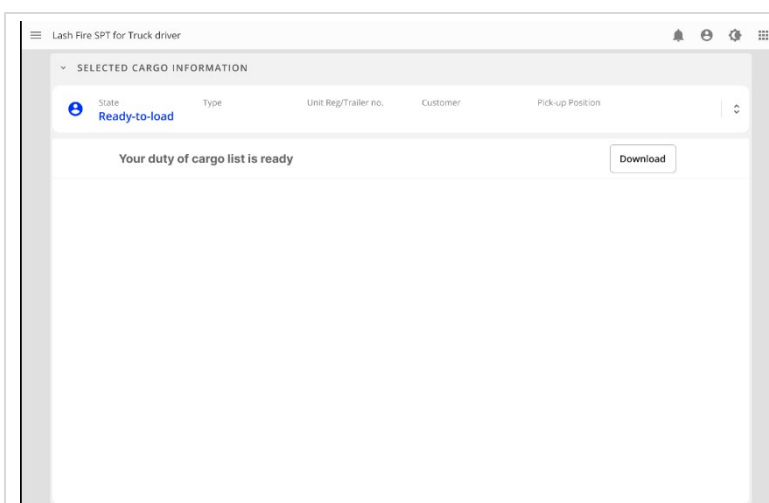The tug driver will send a signal that they are standing by to start loading.

Figure 23 Download updated duty of cargo list

An updated duty of cargo list will be sent to the tug-driver.

Figure 24 Cargo table for tug-driver to select a cargo unit for loading

The tug-driver will be presented with a list of the cargo to be loaded.
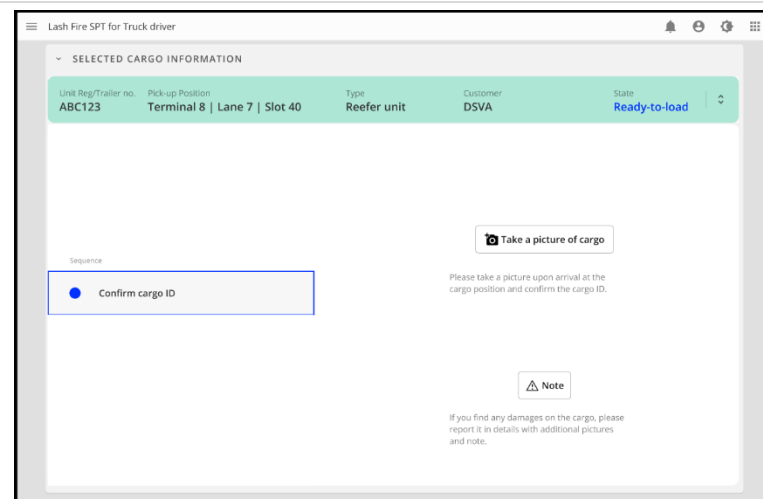

Figure 25 Step 1: confirm cargo ID

Upon selecting a cargo unit, more detailed information will be shown, together with the first steps of the guided task sequence. The first step is to confirm the cargo ID, which in this example is done by taking a photo and uploading it.
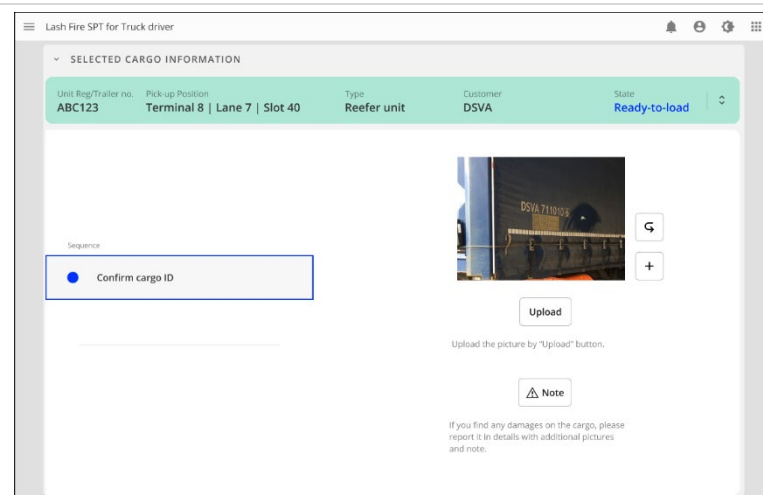

Figure 26 Prompt to register damage

At this point, the tug-driver is also prompted to register any visible damage.
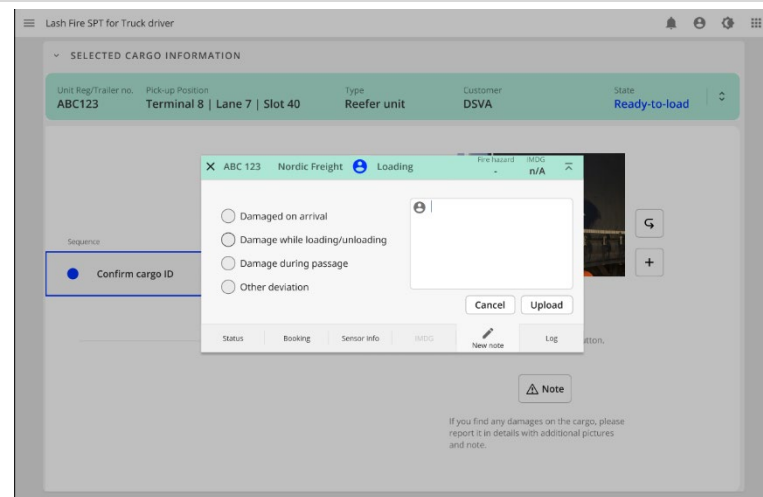
Figure 27 Pop-up to register damage

Clocking on the NOTE button here opens a pop-up of the cargo card, with the "new note" option selected.

Reporting damage is possible any time during the loading process, by expanding the cargo information which displays all the information available in the "cargo card" in the table.
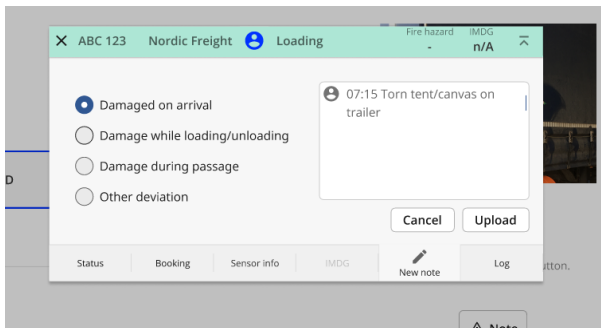

Figure 28 Dialog to register damage

The demonstration participant was asked to make a damage report. The damage report will be visible for any user of the SPT, as this information is to be updated in real time, and accessible through the cargo card which is a common element providing detailed information about individual cargo units, for all users.
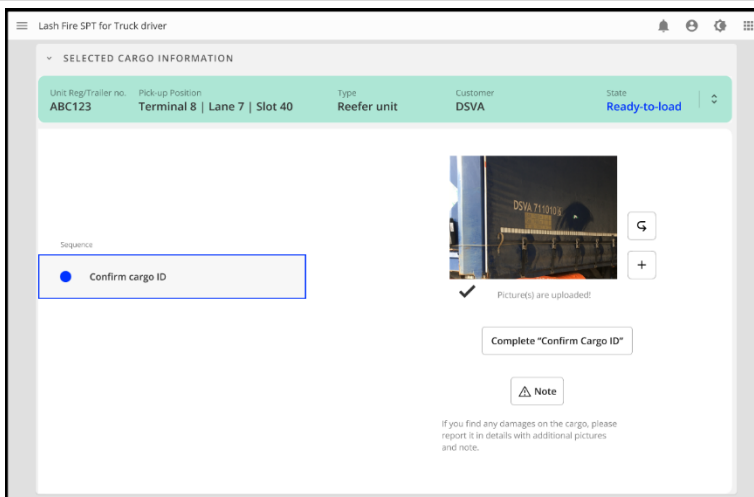

Figure 29 Complete Cargo ID step

Once the note was made and the picture confirming the cargo ID taken, the participant is led to the next step in the task sequence.

Figure 30 Confirm that cargo is picked up
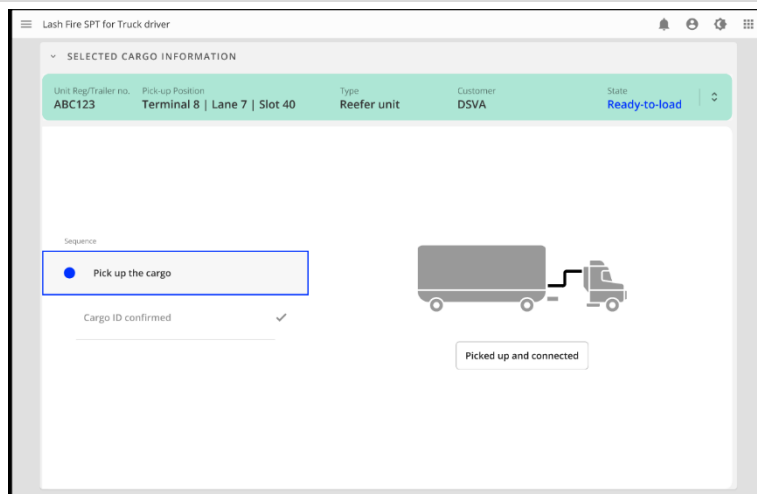
The tug-driver is requested to confirm that the cargo is picked up.
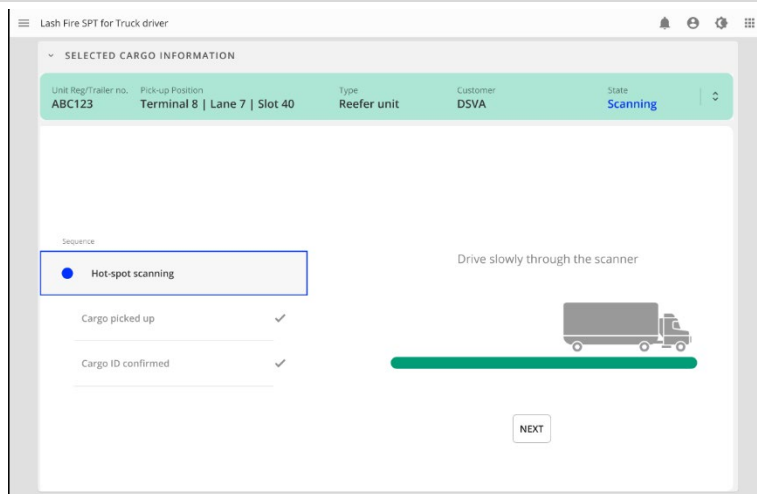

Figure 31 Prompt to drive to the VHD

The next step is to drive to the VHD.
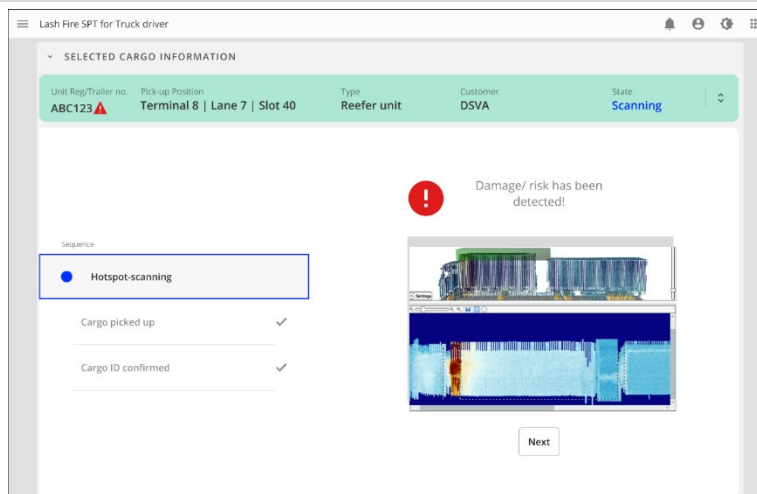
Figure 32 Presentation of scanning results

The GUI shows the scanning results in a clear way. In this case, a hazard has been detected, and the new cargo hazard rating is indicated in the cargo information across the SPT system.
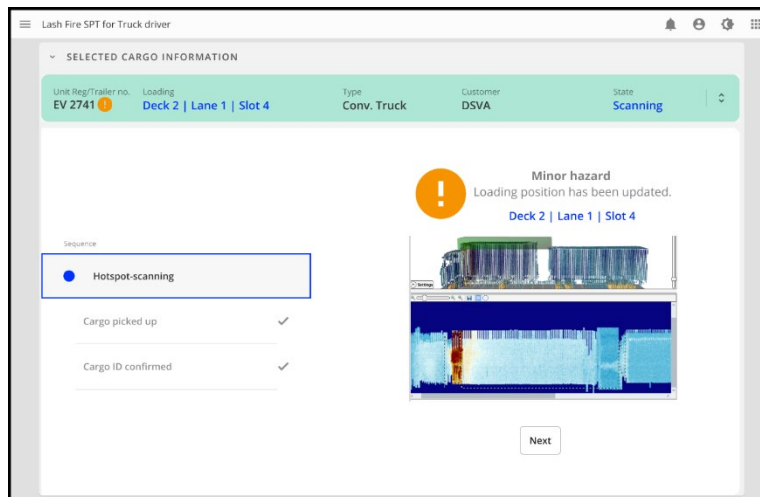
Figure 33 Loading position updated

In this example, a minor hazard has been detected, and subsequently the loading position has been updated.
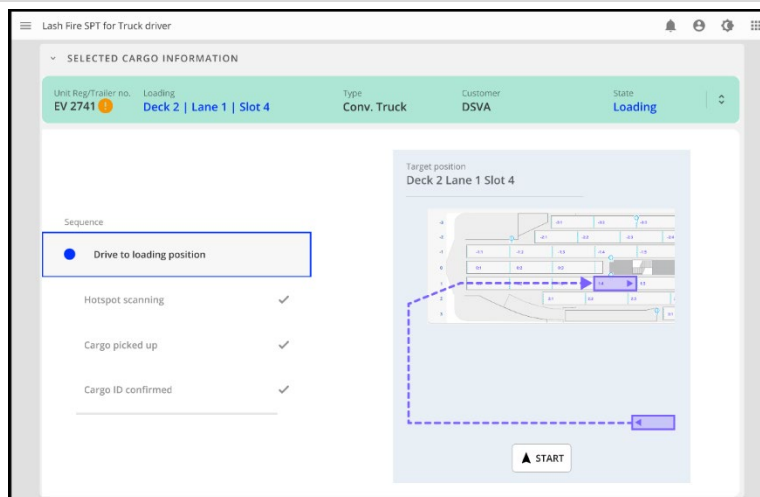
Figure 34 Guidance to loading position

After scanning is completed, the driver is provided with visual guidance towards the correct loading position.
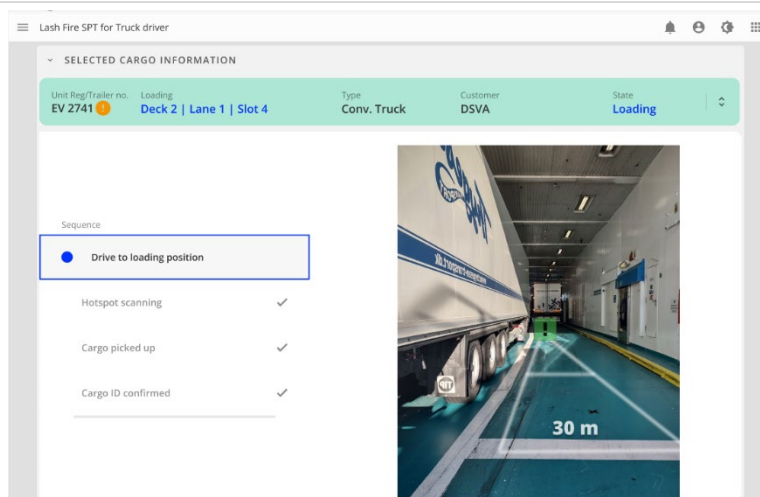
Figure 35 Mock-up of HUD

This phase can be supported by a variety of technical solutions. In this mock-up for the demonstration, a simple mock-up of a head-up-display (HUD) was used.
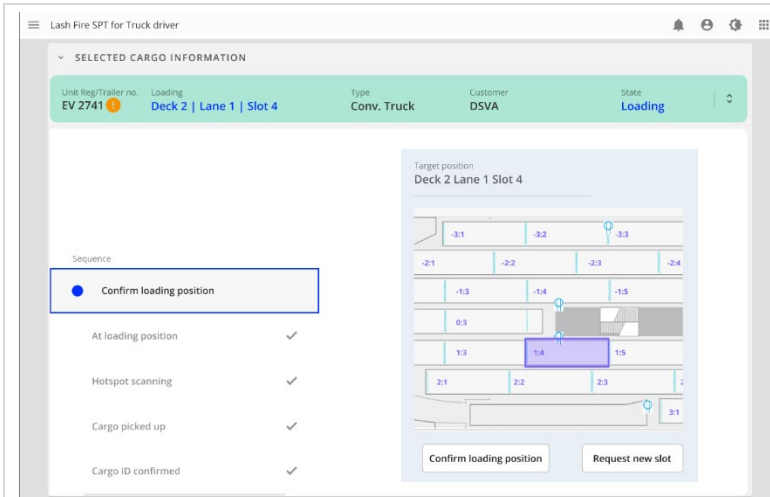
Figure 36 Request new loading position

On arrival at the planned position, the driver is asked to confirm the location, or to request a new position.
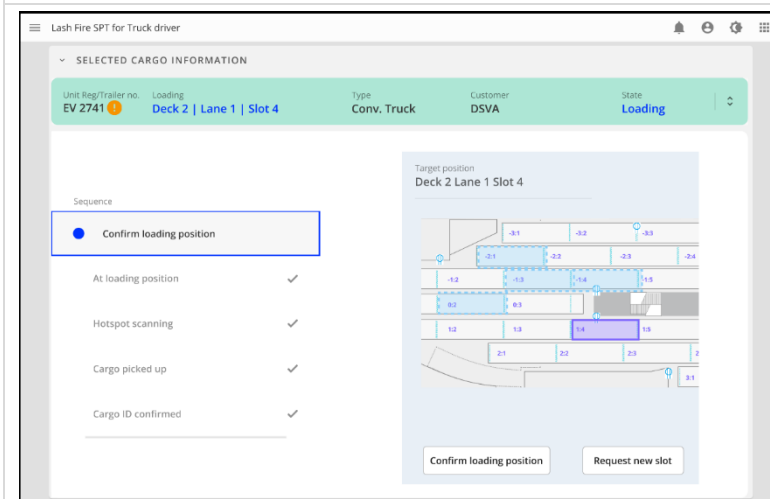
Figure 37 Suggestions of new loading positions

Possible alternative loading slots are shown, and the driver can select one of these. The presented alternative slots should be appropriate regarding fire hazard.
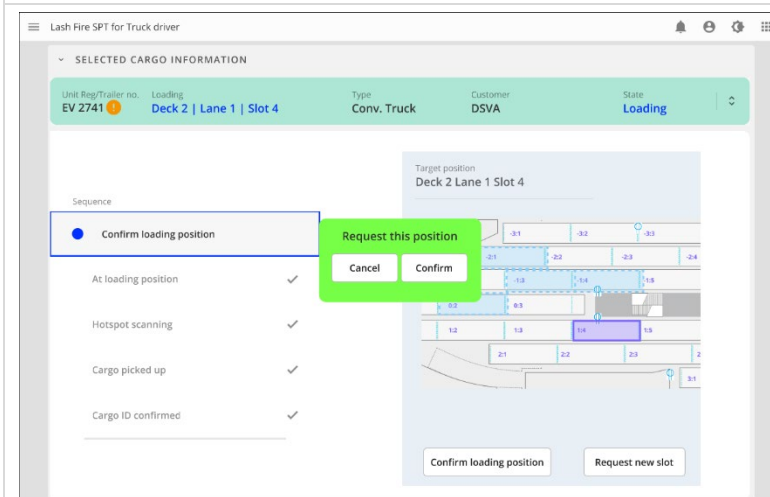
Figure 38 Confirming new loading position

Choosing an alternative position will require adjustment of the stowage plan and updating of the stowage instructions to drivers and deck crew.
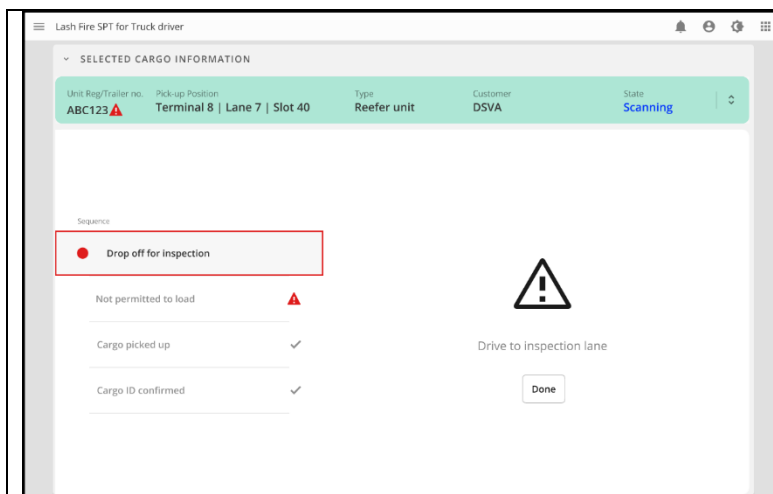
Figure 39 Updated hazard rating

The rating for the cargo unit has been updated, and the tug-driver is instructed to drive to the inspection lane.
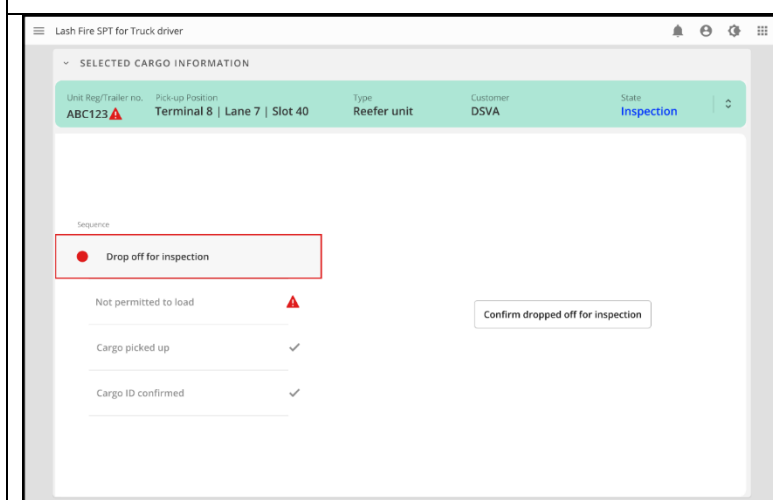
Figure 40 Confirm drop-off at inspection lane

The driver is asked to confirm that cargo unit has been dropped off at the inspection lane.

The driver can then once again select a unit to load form the cargo table.

4.3.2   Deck crew GUI

This section described the workflow for the crew working on deck during loading. The main views are the Loading status page, which summarises important information to help the user to quickly gain an overview of the current work situation; the Deck page, which shows a table with cargo units and also a visual representation of the deck and planned/loaded cargo for each respective deck. "Incoming cargo" is a view that is intended to support deck crew in correctly identifying and guiding the vehicles being driven on board. Table 4 shows the workflow that a user meets during the loading process.

Table 4 The workflow for use by deck crew
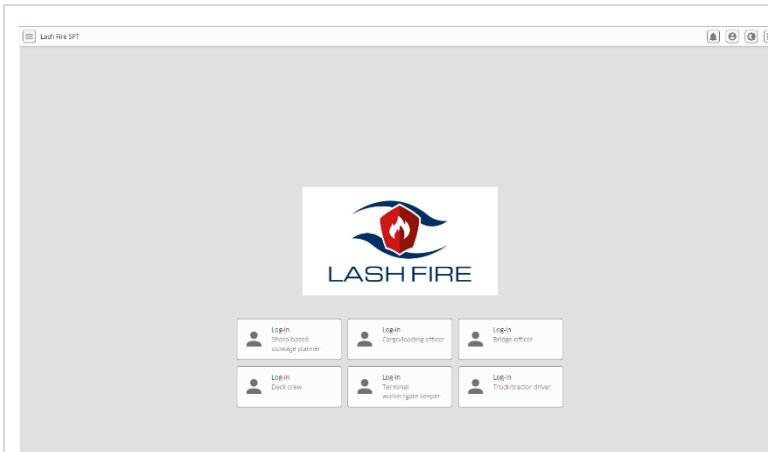
Figure 41 Log-in page	Log-in: The user enters through a log-in page which provides access to the functions they have permissions for.
Figure 42 Deck crew request to stand by	Landing page: the user is met with personalised information, here with a notification that loading is about to commence and that they can report when they are standing by.
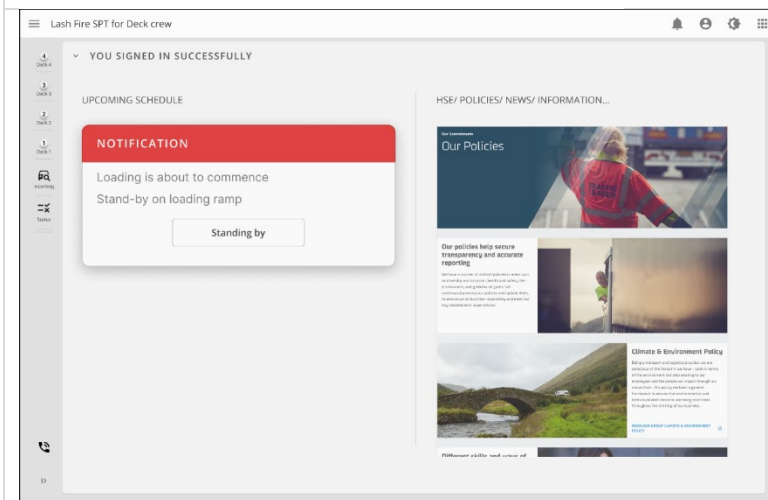
4.3.2.1   Loading status and deck page
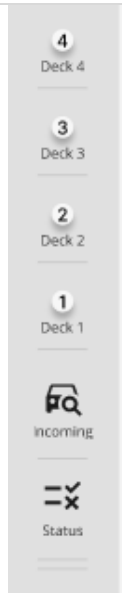
Figure 43 Left side menu

The left side menu affords navigation, here described descending from the top of the menu: *Deck page*- loading information for each deck (Figure 19 Deck page, cargo list) *Incoming* – a page with updated real-time information about the cargo units that are currently being loaded (Figure 23 Incoming cargo), and *Status* - a summary of relevant cargo and loading information (Figure 18 Loading status overview).
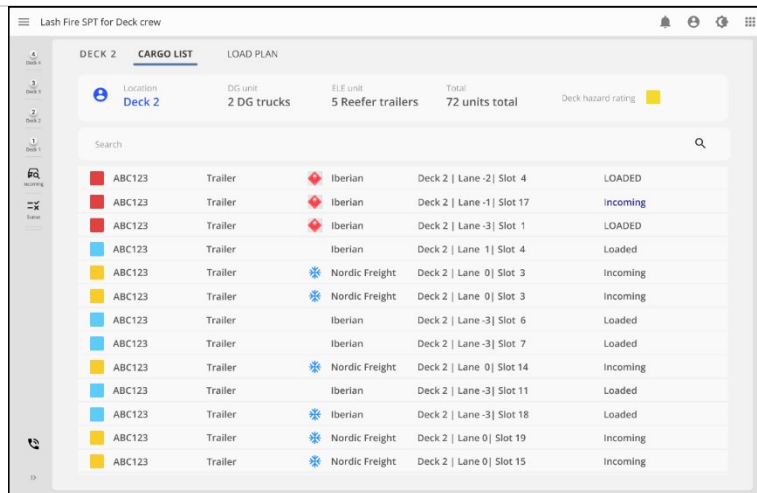
Figure 44 Deck page, cargo list

Deck page: each deck is represented by a page that is accessible from the vertical menu on the left.
Each deck page has two tabs: the Cargo List, which is a list of all the cargo on the respective deck, and the Load Plan for that particular deck.
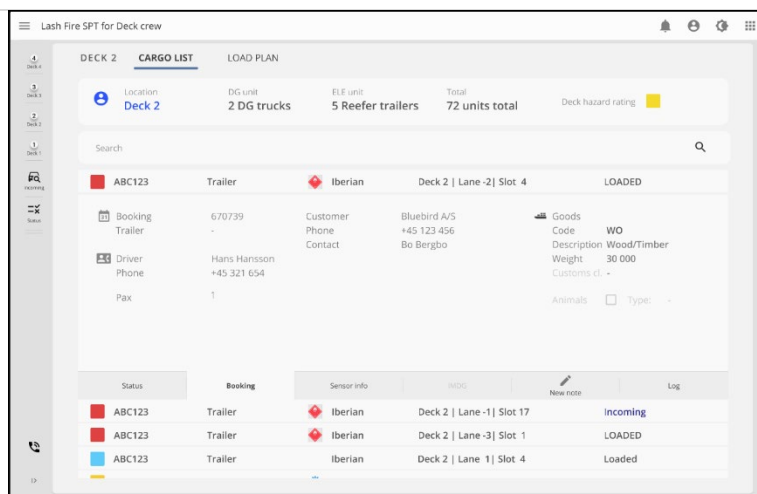
Figure 45 Displaying detailed cargo information in the cargo list

The rows in the cargo list can be expanded, showing details about the cargo item via the "cargo card" layout.

The hazard rating for each deck is shown by an icon on the upper hand-hand corner.

Figure 46 Load plan for deck 2

The Load Plan shows the general arrangement of the deck and the planned cargo, as well as loading progress.

Trailers placed by tug-drivers, and trucks driven on board by truck drivers are distinguished by colour-coding.

Already loaded units are distinguished from those not yet loaded by colour coding. A key to the colour coding is also provided.
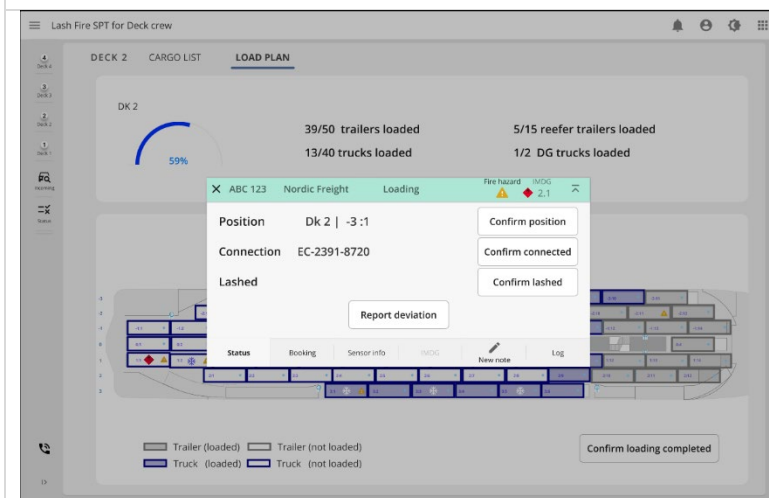
Figure 47 Confirmation of loaded cargo

The load plan view can be used e.g., if crew need to confirm loading positions: clicking on a cargo unit on the visualisation of the deck can open a dialogue that supports this part of the work process.

4.3.2.2   Incoming cargo

The incoming cargo view provides the deck crew with several options for keeping track of the cargo being loaded. Table 5 shows screenshots with short descriptions.

Table 5 Workflow incoming cargo
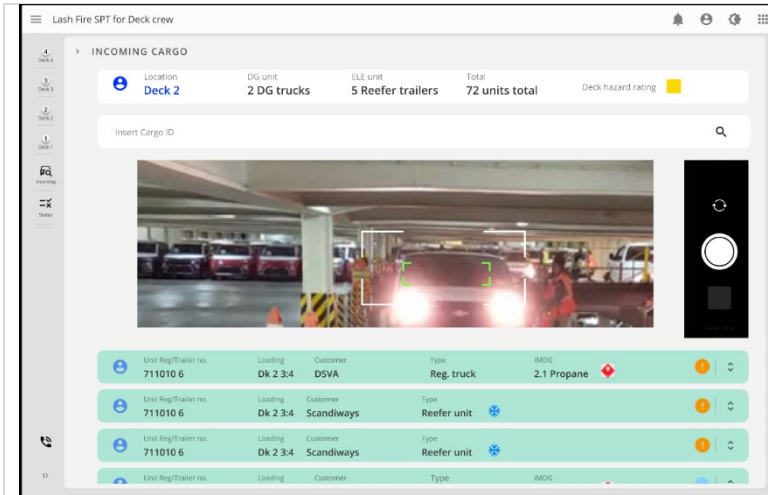
Figure 48 Incoming cargo

The user can identify incoming cargo by typing the registration or customer name in the search box. The user can also click on an item in the incoming cargo list or direct the camera of the tablet towards incoming cargo, to identify an incoming unit.
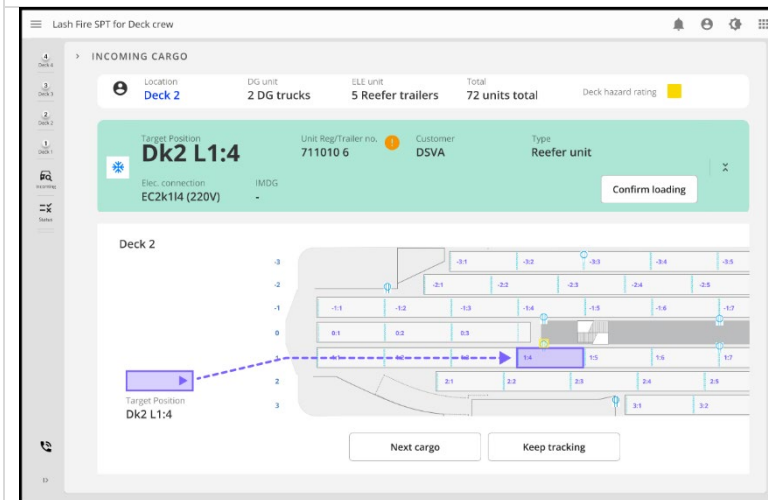
Figure 49 Showing the loading position of a cargo unit

When a cargo unit has been selected, the loading position will be shown, in a way which supports the deck crew in directing incoming cargo units. From this view, crew can access functions to confirm that a unit is loaded.
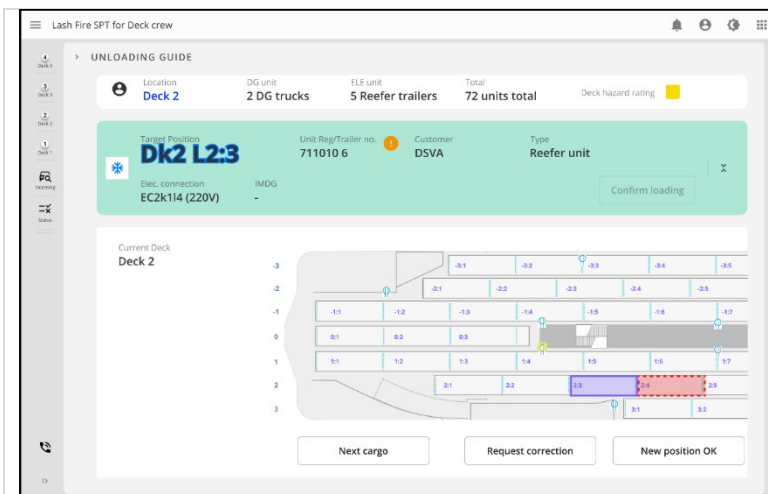
Figure 50 Tracking a cargo unit during loading

There is also an option for tracking the loading of a particular unit, and to answer to a request for a new loading position.
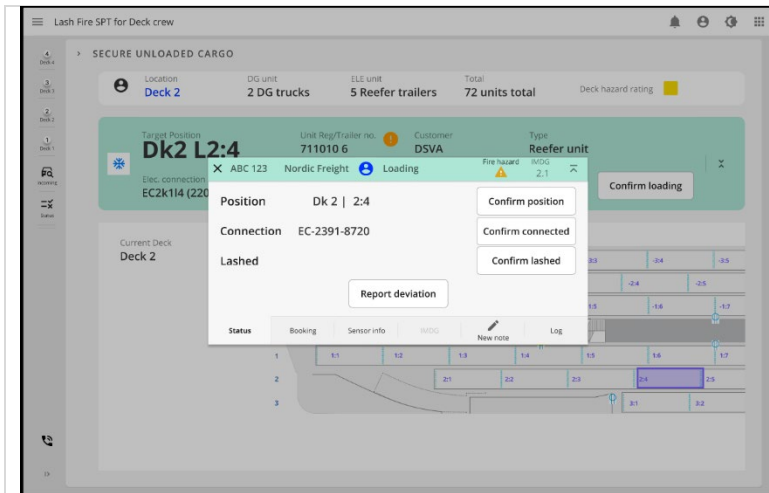
Figure 51 Dialog for confirmation of loading

The dialog for loading confirmation is intended to support the checking of loading positions, electrical connections and lashing. It also provides an option for reporting deviations.

4.4   Demonstration objectives

The assessment of the SPT during the demonstration focused on how well the prototype answers to user needs and expectations. The demonstration aimed to be a proof of concept, where the SPT underwent an assessment focusing on usefulness and usability of the user interface, gathering feedback from users about perceived usefulness and confidence in the SPT's ability to accurately manage and display fire hazard ratings, and ensuring that safety regulations and best practices are adhered to.

The demonstration's main objective was to gain user feedback on prioritized features of the SPT – the hazard rating and cargo distribution algorithms, through involvement of ship and terminal operators.

The STP visualization builds on the design detailed in D08.3 and is designed to support the different scenarios and contexts-of-use described D08.4. The design conforms to ISO 9241-210 [2] through end-user involvement in the design, as well as testing/assessment by end-users.

4.5   Demonstration media

The demonstration was conducted using standard laptop monitors, as the participants in both online and in-person demonstration sessions were provided with URL links which gave access to the prototype through a web browser.

The mock-up for the planner was made in Axure, which is a leading prototyping tool that has affordances for crafting detailed and highly interactive, dynamic user interfaces. enables an accurate depiction of the proposed tool's functionality, promoting a comprehensive understanding of its operation. The mock-ups for the tug-driver and deck crew were made in Figma, which has an intuitive design interface that allows for swift iterations, and in which the OpenBridge component library [1] is available. This component library is a design system specifically tailored for maritime workplaces and equipment, which aims to reduce the problem of users being confronted with many different design languages in the equipment in their workplace.

4.6   Preparatory actions

This section outlines the steps taken to plan the demonstration.

4.7   Development of the prototypes

The prototypes in the demonstration have been developed through several iterations, based on early user requirements work, conceptual UX design and the design of the software developed by CIMNE, which is described in detail in D8.2 and D8.4.
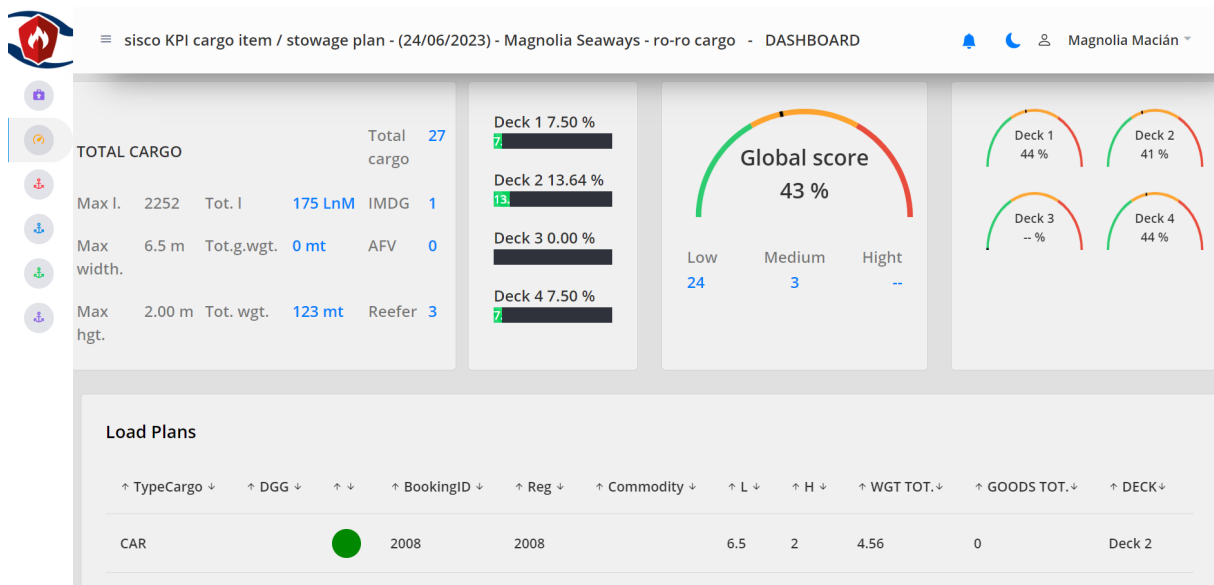
Figure 52 Screenshot of the user interface of the software tool developed by CIMNE, described in D8.2
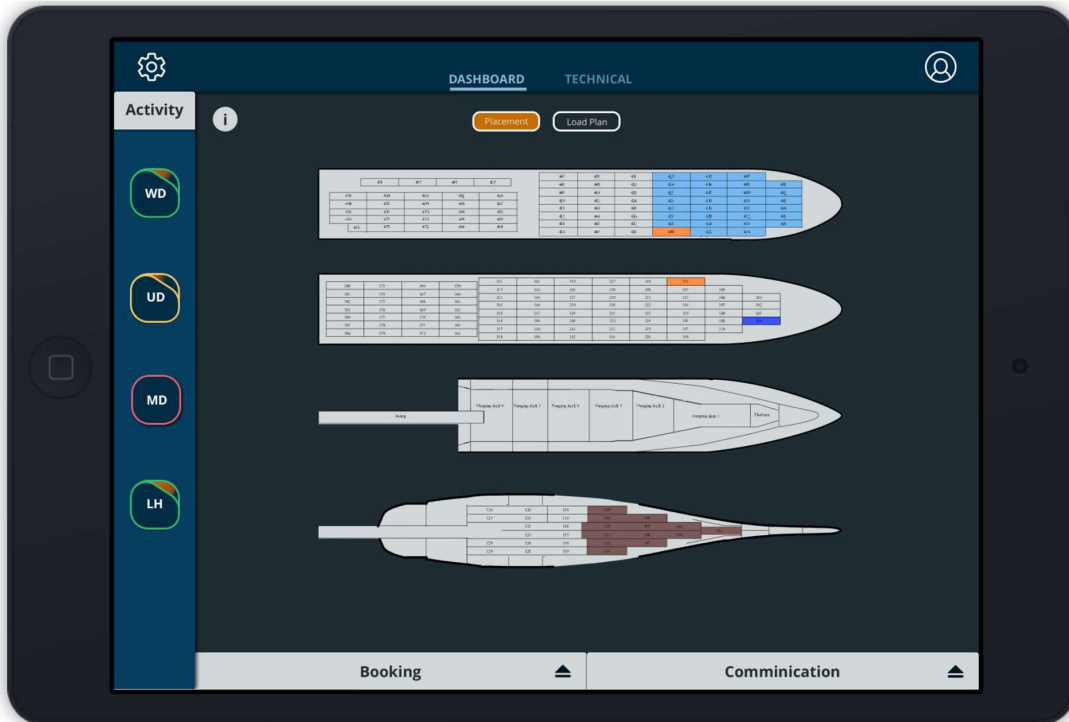
Figure 53 Screenshot of the earlier LASH FIRE SPT Clickable demonstrator described in D8.4

The earlier LASH FIRE SPT clickable demonstrator described in D8.4 (figure 49) can be found at
https://projects.invisionapp.com/share/THHNGHCGJZC#/screens/292891686
The design of the final mock-ups that were used in the demonstration was based feedback from
potential users and expert evaluation conducted in February 2023.

4.8   Procedure

The planned procedure for the demonstration is outlined below. The procedure was similar in the
online and the in-person sessions.

Briefing: The session will begin by introducing the stowage planning tool and describing the
procedure.

Task scenarios: Participants will be asked to perform according to defined task scenarios that are
intended to simulate real-world situations while using the stowage planning tool.

Data collection: The participants' interactions with the tool, including any difficulties or errors, will be
noted. The sessions will be recorded.

4.8.1   Demonstration scenarios

This section details the demonstration tasks. The context of use encompasses users, objectives,
tasks, resources, and the technical, physical, and social contexts and organizational settings in which
a system or product is employed. The section below summarises how the main users' objectives and
tasks have been defined, as well as the use cases linked to each group of users.

4.8.1.1   Shore-based planner

The main tasks for the shore-based planner during the demonstration is to perform fire hazard
management with an existing stowage plan created in an external system and imported to the SPT.
The following test tasks are intended to reflect typical user interactions and key functionalities for
the Shore-based planner:

1. Inspect information about a specific cargo unit
2. Obtain fire hazard ratings of individual cargo items
3. Obtain fire hazard ratings for a stowage plan
4. Search for a given unit

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5. Approval of the stowage plan
6. Export or share the stowage plan

During the test extra attention was paid to user feedback on:
- The visualization of the risk level of cargo located on each deck
- The visualization of the overall risk level of the ship's cargo
- The possibility to display deck plans of all the predefined ships
- The colour coding distinguishes dangerous goods from other non-dangerous goods.
- User interactions to make modify stowage plans and to modify them based on feedback from the cargo distribution algorithm features.

4.8.1.2   Tug/tractor driver

The main tasks for the tug/tractor driver during the demonstration was to simulate the loading process and to provide feedback on the information and the workflow. The following test tasks were intended to reflect typical user interactions and key functionalities for the tug/tractor driver:

1. Selecting a cargo unit from a set of assigned cargo
2. Confirming that the correct unit is picked up
3. Making notes on damage
4. Signing off on the fire hazard scanning
5. Guidance towards the correct cargo placement
6. Confirming that the cargo unit is in the assigned placement
7. Requesting an alternative placement

4.9   Test Schedule

Pilot test: two weeks before the demonstration a pilot test was conducted to identify issues or problems with the test plan and materials.

Test sessions: Each participant was scheduled in an individual session, expected to last between 30 - 60 minutes.

4.10 Recruitment of demonstration participants

Requests were sent to LASH FIRE partners to recruit participants that correspond to the main user types, and the test schedules were set according to these participants' availability. Each participant received an invitation letter with details about the project and about the demonstration (Annex A – Invitation to participants).

5   Demonstration

The demonstration was conducted in a task-based approach, with one participant per session. Two sessions were in person and three sessions were conducted online.
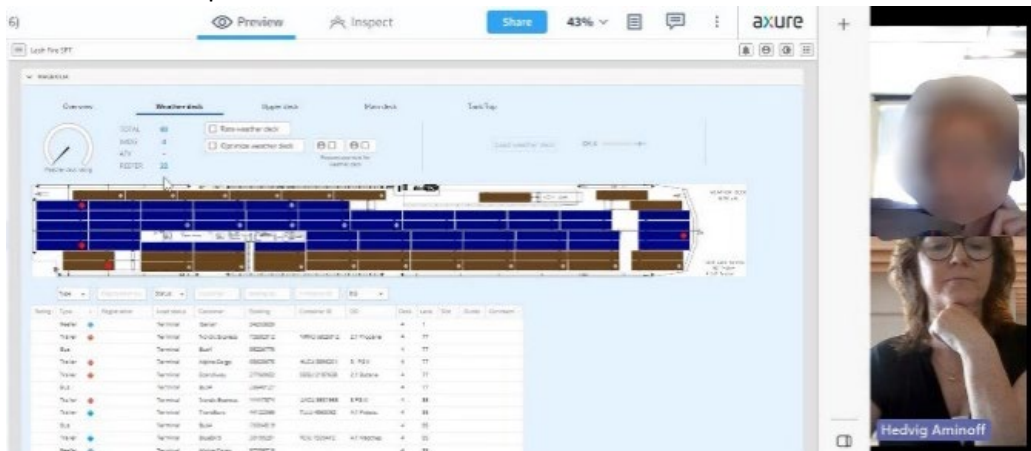
Figure 54 Image showing one of the sessions conducted online.

Each participants tested all the mock-ups, as this was a way to gain more feedback and also to show how the information and user interactions with the system would be communicated across the system, for example that when a tug-driver confirmed that a unit is loaded this will also be visible for a cargo officer.

Each participant was given a brief introduction to the demonstration's purpose and the tasks, as well as the SPT's intended functionality. They also received a short explanation of how fire hazards are calculated in the tool developed by CIMNE. Participants were then asked to interact with the mock-ups to complete tasks that reflect typical user interactions in their roles.

During the test, participants' interactions with the tool were observed and recorded. Difficulties or challenges faced, were noted. Participants were also encouraged to share their thoughts and feedback verbally throughout the process.

Data were collected on task completion and errors, as well as subjective feedback on ease of use and usefulness of the tool.

5.1   Tug drivers during loading

The tug-driver tasks were as follows:

1. Selecting a cargo unit from a set of assigned cargo
2. Confirming that the correct unit is picked up.
3. Making notes on damage.
4. Signing off on the fire hazard scanning
5. Guidance towards the correct cargo placement.
6. Confirming that the cargo unit is in the assigned placement.
7. Requesting an alternative placement.

5.2   Deck crew during loading

Deck crew tasks were as follows:

1. Checking loading status
2. Navigating to the Deck page.
3. Reviewing cargo details
4. Checking hazard ratings
5. Identifying incoming cargo
6. Using the loading confirmation dialog.

5.3   Planner role- fire hazard ratings and cargo distribution algorithm.

It is important to be aware that specific roles and their responsibilities can vary between shipping companies and types of vessels, for example between RoPax and RoRo, and that planning tasks may involve other roles such as the Chief Officer or First Officer.

The tasks for the stowage planner were as follows:
1. Selecting a departure.
2. Go through the process of generating fire hazard ratings for a stowage plan.
3. Use the tool to generate a stowage plan with reduced fire risk.

6   Results

Overall, the demonstration showed promising results, with new insights into user needs and expectations, and indications about room for improvement to the design. The main point for improvement was that information about any changes made to an existing stowage plan during the fire risk reduction process is crucial and needed to be more explicit. Trust and user adoption will depend on factors such as the stowage planning tool's reliability, transparency, and adaptability. The discussions indicated that users need to understand how the system arrives at its recommendations, and that this would encourage adoption of the system in everyday work.

Furthermore, users wanted the option to manually adjust a stowage plan, even after the cargo distribution algorithm has been run.

The following sections provide more details about results from the three use scenarios.

6.1   Demonstration results, tug driver view

Participants found the cargo list information sufficient for cargo unit selection and appreciated the straightforward pickup confirmation process. The fire hazard scan process was a little confusing to at first, but appeared helpful once they had a chance to try it a few times. Damage reporting was deemed useful and easy to use, especially attaching photos to the damage report. When asked about cargo placement directions, participants found them clear and easy to understand (the prototype simulated a HUD-display), but that the process of requesting alternative placement could be more intuitive.

In terms of how the tool could support daily work, a tool that integrates the VHD fire hazard scan, hazard ratings, fire hazard management regarding the stowage plan, and detailed cargo information as well as loading status was very positively received and seen to have potential to not only streamline the work process but also provide important information in the event of a fire, as well as raising awareness about fire hazards.

Participants echoed each other's feedback about the cargo list and pickup confirmation, finding the fire hazard scan a bit confusing at first, but quickly understanding the flow and agreeing it would be valuable in practice. The cargo placement instructions were a point of discussion, as guiding a driver to a specific location could be implemented in many different ways technically.

In conclusion, participants found the tool very useful and intuitive, but suggested a few areas for improvement, such as the alternative placement request process.

6.2   Demonstration results, deck crew view

The Loading Status page was considered an effective in providing a quick overview of the work situation, however the participants expected this information to be presented in a more effective way. The participants understood the tool's navigational design, for access to the specific deck pages. The feature allowing for an expanded view of the Cargo List was highly appreciated, as it enabled participants to access detailed information about specific cargo items quickly and efficiently. The hazard rating icons were said to be clear and were acknowledged as a useful safety element.

The tool's Incoming Cargo view was seen as an option that could support efficiency, especially the search feature, which aims to allow users to identify specific cargo units quickly and easily. However, the proposed option of pointing the tablet camera at an incoming unit for identification sparked mixed reviews; while innovative, some participants expressed concerns about its practical use in a realistic work environment.

Participants found the loading confirmation dialog useful and effective, particularly the features that allow them to check loading positions, electrical connections, and lashing. The option to report deviations directly through the tool was considered a significant advantage, contributing to both the tool's efficiency and user satisfaction.

Overall, the deck crew perceived the stowage planning tool to be beneficial for their roles, particularly highlighting the fire hazard ratings and reporting deviations features. Yet, the feedback suggested a need for further investigation into the content and representation of the loading status, information, and if there are practical solutions for scanning cargo units to identify the vehicles coming on board, given the mixed responses it received.

6.3 Demonstration results, planner view

Users expressed considerable confidence in the fire hazard management aspect of the tool: that the background of how the fire hazard ratings were developed appeared insightful and that the tool had potential to streamline the planning process while improving safety.

While generating fire hazard ratings, the users found the tool useful but suggested that a help section with explanations of the rating factors would be helpful. Similarly, it would be useful to have keys to explain all icons and colour coding, even though the participants emphasised that once this had been learned it would be preferable to avoid unnecessary clutter.

For example, one participant said this type of tool would save both time and effort, under the condition that the placement constraints for each deck could be easily configured and modified. As an example, it would be important to be able to accommodate settings to avoid towage in sections where there was planned or ongoing maintenance work, or stowage preferences due to weather conditions. Users expressed that they felt comfortable with the fire hazard management tool and appreciated its intuitive design, however all the participants emphasised that they might also want to make manual adjustments: "It's good to have the tool suggest the optimization, but it's also important to be able to make manual changes."

Another point of discussion was that it was crucial that the fire hazard management recommendations are accurate. One participant noted, "I can understand that the tool takes into account a range of factors for fire hazard. However, for me to trust it fully, I would like to understand more about how these ratings are calculated and what regulations or guidelines they are based on." Regarding the cargo list and deck map, participants found the sortable cargo list very practical, especially the sort and filter options.

One participant noted, "If the guy from shore sends us an email that the temperature has to be changed on a reefer I need to know: where is that reefer? This makes it possible for me to just quickly put in the container number here and then it will show me where it is."

Suggestions from users were that highlighting hazardous cargo in a distinctive colour could be beneficial, as the icons used could give a cluttered impression. As for the cargo card, they found the tabs easy to navigate but mentioned that the exact content of the card should be possible to change if needed.

The visual representation of cargo on the deck map was seen as useful, especially how clicking on cargo units presented more information and that it could highlight the respective row in the cargo table. Similarly, the cargo card was seen as providing a comprehensive summary of cargo information, with several comments about how information about drivers and passengers could be

useful in the event of a fire. However, it would be important that the information integrates real-time updates on cargo status.

Another issue with the design was the predetermined loading slots. This conflicts with one of the planner's main goals: to fit as many vehicles as possible onto the deck. This is because of a large variation in vehicle lengths in Roro traffic, which in this sense differs from cargo ships in which standard containers are the norm. Using a lane meter approach would be more efficient, where the deck space is not divided into fixed slots but instead referenced in terms of the total length available for stowage. This would allow for greater flexibility. Also, this can make it easier to accommodate last-minute cargo additions or substitutions. This feature is supported by the SPT, but all the tests were conducted to verify that units can exchange their slot with other units of the same size because of the complexity to check if the algorithm works properly with full flexibility (time to test this was out of the available timing)

Stowage planners also emphasized that it should be easy to adjust loading constraints on the decks, as these restrictions directly influence how the cargo distribution algorithm generates the improved stowage plan. These constraints must be flexible and easy to adjust, sometimes daily, to account for factors such as maintenance on a deck, or changing weather conditions, which also is taken into consideration during planning.

All participants were positive about the tool's fire hazard management features, particularly the easy access to detailed cargo information.

7   Analysis and discussion

The demonstration provided rich feedback from users that contributed to a deeper understanding of the tool's potential applications and areas of improvement. Participants highlighted the importance of clear and immediate updates on changes made during fire hazard management, particularly regarding the positioning of dangerous cargo, as well as other cargo units with a high hazard rating. Ease of access to a cargo unit's details was seen as essential information for all crew, not just the officers on board, and the expectations of the information to be displayed varied strongly between the individual participants, which indicates a need to be able to make different configurations for different types of users but also depending on personal preferences.

The integration of the stowage planning tool into the current workflow was a significant discussion point, with users indicating the desire to move towards a more paperless system. The tool's ability to consolidate various pieces of information into one system could reduce the need for extensive paperwork, making information sharing easier and more efficient. However, the reality of current work, where information is fragmented across multiple systems points to a need to allow for easy printing of the information in the SPT, to make sharing easy.

The user feedback also highlighted the difference in the feasibility of using the SPT for planning RoPax versus planning RoRo ferries. In general, RoPax ferries, have a greater variability in vehicle types, sizes, and in many cases quick turnaround times in port. In addition, vehicles are driven on board by the vehicle owners rather than by tug drivers. This will pose a greater challenge for detailed stowage planning. However, users suggested that partial pre-planning, restricted to vehicles with a higher hazard potential for example the placement of trucks and electric passenger vehicles, could be a way to enhance safety without disrupting the loading workflow. Even if not every individual car could be placed according to a detailed plan, the overall stowage plan would still provide valuable insights into potential fire hazards, which would be useful for firefighting strategies.

The discussions brought to light how the stowage planning tool could be useful for firefighting. Users pointed out that, in case of a fire, crew members sent to deal with the situation might not be familiar with the detailed loading plan. Providing them with easy access to a screenshot of the loading plan, especially indicating the location of hazardous cargo, could prove vital in such scenarios. The

consensus was that the stowage planning tool holds promise in enhancing shared awareness and preparedness for handling onboard emergencies.

Effectiveness, efficiency, and satisfaction are essential metrics for evaluating the quality of the interaction between a user and a product according to ISO 9241-201 [2].

Effectiveness in this demonstration is discussed in relation to concepts such as the accuracy and completeness with which users achieved specified goals. Participants were successful in completing their tasks, implying good effectiveness. Adding features to support manual adjustment of cargo distribution algorithm's results might enhance task effectiveness. Participants suggested more transparency in how fire hazard ratings are calculated, which could enhance the effectiveness of users' understanding and decision-making based on these ratings.

Efficiency pertains to the resources expended in relation to the accuracy and completeness of goals achieved. Participants appreciated the fire hazard management tool's potential to save time and streamline the stowage planning process, indicating good efficiency. However, participants also noted the need to be able to make manual changes, which implies a balance between automated fire hazard management and user control for optimal efficiency. Participants found the cargo list and cargo card features very practical, which could significantly improve task efficiency. Participants said that they currently use a several different systems and that a tool that could pull in information from all these systems and help with fire hazard ratings would make work more streamlined. However, there was also discussion about how to achieve compatibility with existing systems.

Satisfaction in this demonstration is related to participants' perceptions of the ease of use and usefulness of the prototype. Participants expressed that they found the tool easy to use once they had acquainted themselves with the design and appreciated the layout, indicating a high level of satisfaction. They also found the fire hazard ratings and cargo distribution algorithm useful, and valued real-time updates on cargo status, further indicating satisfaction. However, they also suggested improvements such as a help icon with explanations of rating factors, and highlighting hazardous cargo in a distinctive colour, rather than the symbols used, which could further enhance user satisfaction. Different shipping companies include different types of information and terminology in their planning process, and it is preferable if users can configure the order and content of the cargo lists, so that they suit user needs during planning and keeping track of cargo.

In conclusion, the demonstration indicates that the SPT has potential to improve efficiency in stowage planning and to raise awareness about fire hazards. Participants did suggest more transparency of how fire hazard ratings were calculated, and ways to provide flexibility in fire hazard management during stowage: mainly that the option for manual adjustments was important.

7.1   Future work

Future work can encompass a broad range of aspects, such as how he SPT can allow stowage planners to optimise the space used, and how planners can accommodate last-minute changes in smoothest way. Introducing this type of tool may also create synergies with the organisation of work, such as automation of repetitive tasks, and a wider range of smart suggestions based on past plans or best practices. This type of tool may also contribute to sustainability if it also helps calculate the weight distribution of the loaded cargo accurately, which in turn can be a path towards reducing fuel consumption.

Regarding more advanced features, the SPT could be augmented with features to support reporting and analytics, which would enable stakeholders to monitor performance, identify trends, and make data-driven decisions. These types of features can give better customer service, in the form of for example tracking freight, and improved accountability in case of damages and delays.

Security and privacy are another area for future development. Given the sensitive nature of cargo information, cargo owners may be reluctant to share detailed specifics. The system should also be

interoperable, ensuring accurate and efficient integration with other related systems, like booking systems, to allow for data exchange without inconsistencies or errors.

The usability aspect of the system will be important. The tool will be used by experts, which implies that it is more important that it works well for an experienced user than that it is immediately understood by a new user (a characteristic which is more important in consumer products). On introduction of this type of system it is however important to provide clear instructions and necessary documentation to support initial learning. Similarly, the visual design of the tool, including colour scheme, font choices, and graphics, which were not a current priority, will be essential in the later stages of the tool's development.

The system should also integrate seamlessly with existing work practices and facilitate a smooth transition from current methods to this digital solution.

8   Summary and conclusion

The SPT is designed to help users evaluate a voyage's overall risk and to assess or enhance a stowage plan. It should enable planners to effectively compare and modify plans and should integrate with existing stowage planning systems, particularly for IMDG cargo unit management.

The feedback gained during the demonstration was positive, yet there were also areas of concern that emerged. The hazard ratings feature was particularly appreciated for its potential to increase shared awareness of fire hazards. Knowledge about the location of hazardous cargo or risky zones was perceived as a significant advantage. This feature not only contributes to improved fire patrol planning but also, as one participant interestingly noted, adds an element of interest to the routine task of fire patrols. The added depth of understanding about the risk landscape on the ship can lead to a more engaged and informed crew, enhancing safety measures on board.

One area of importance was the expressed need to understand and trust the cargo distribution algorithm. Users suggested more detailed information, particularly during the initial stages of adoption. It may be expected, that as users become more familiar with the tool, the need for this guidance might decrease, but it should be considered crucial for smooth implementation and initial trust-building.

The mock-up of the stowage planning tool also exemplifies how information can be efficiently integrated with the Digital Fire Centre (D7.5). The SPT would contain comprehensive cargo information that could feed directly into the Digital Fire Centre. The information would include specifics such as cargo type, weight, and size, along with hazard ratings associated with each cargo unit.

Recurring GUI elements like the cargo card and deck layout would provide consistency, ease of use, and efficient navigation within the system. The cargo card gives an at-a-glance overview of the cargo specifics and hazard ratings, allowing for quick assessments and decisions. Similarly, the deck layout offers a visual representation of cargo placement, enabling users to perceive potential risk clusters and plan accordingly.

The hazard ratings, which are a central aspect of the SPT, provides crucial details about potential risks related to each cargo unit. The demonstration indicates that the SPT concept can contribute significantly as a preventive measure, and that it has potential to support decision-making processes planning, as well as emergency responses, by reducing the risk inherent if the distribution of cargo on ´board, but also by a clear picture of potential fire hazards, which for example can support fire patrols.

In addition, integration between the stowage planning tool and the Digital Fire Centre would allow for easily accessible updated information in the event of a fire. The SPT can enhance the effectiveness and efficiency of the Digital Fire Centre by ensuring quick access to vital data that would support decision-making in emergency situations.

9 References

[1] "OpenBridge Design System," [Online]. Available: https://www.openbridge.no/figma/current-release. [Accessed 15 6 2023].

[2] International Organisation for Standardization, "ISO 9241-210:2019 Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems," [Online]. Available: https://www.iso.org/standard/77520.html. [Accessed 10 5 2023].

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11 ANNEXES

11.1 Annex A – Invitation to participants

Optimisation Tool demonstration

Participant information

Welcome!

The LASH FIRE* project seeks to strengthen fire prevention and management on roro/ropax ships. One part of this work is to suggest improvements to systems, equipment and environments used by the crew during a fire incident. Within the LASH FIRE project, NTNU and CIMNE have developed a prototype for a digital tool to optimize stowage of cargo and vehicles on RORO-ships from a fire safety perspective.

You are invited to an online demonstration of this prototype, where the main purpose is to learn more about how it answers to potential users' needs and expectations. This is not a test of anybody's skills, but a way to better understand how the proposed design answers to users' needs. The results will be used for project reports, as well as research purposes.

You will recieve a link to the prototype. The session will not take more than an hour, and involves the following steps:

1. You will be given time to familiarize yourself with the system.
2. You will be asked to complete a nu,ber of tasks using the Stowage Planning Tool prototype.
3. Afterwards you will be asked questions about your experiences, and there will be an opportunity for a discussion about the proposed design.
4. You will be asked to fill out a short online questionnaire.

The whole session will be video-recorded and the collected data will be stored securely within LASH FIRE with restricted access. We will provide more details about participation and also ask you to fill a consent form prior to the session.

If you have any further questions before or afterwards, please do not hesitate to contact us.

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11.2 Annex B – Test script

11.2.1 Test instructions, Tug-driver

Introduction

Welcome! Thank you for agreeing to participate in our demonstration today. Your input is very important as we are working to develop the user interface for a tool for decreasing cargo-related fire hazards on board RORO-ferries.

The test will take between 30 to 60 minutes. It involves interacting with a mock-up version of our tool. During this process, we are not testing you, but rather the tool itself. We want to see how intuitive the design is and how effectively the tool supports you in your work.

We are interested in your honest opinion about its ease of use and usefulness. Therefore, please provide comments or suggestions you may have at any point during the test. There are no right or wrong answers. Your feedback will be critical in helping us refine this tool to better serve you and your colleagues in the future.

Thank you again for your participation. Your expertise is important for our design process, and we appreciate your time and insights.

The Fire Hazard Optimization Tool plans the safest way to store cargo on a ship deck. Here's how it works:

Understanding the Cargo and Deck: The tool starts by looking at the cargo manifest, and the configuration of the ship deck.

Calculating Risk: Each cargo unit has a certain level of fire risk associated with it. This risk can be based on the type of cargo, how it's packaged, and other factors. The tool is based on research into real fires and the tool uses this information to figure out how risky each cargo unit is.

Considering Position: Not only does the tool consider the risk of each cargo unit, but it also considers where the cargo units are positioned on the deck, as well as the deck above and below. In addition, the location of stairs, ventilation etc. are also considered. Some cargo units may become more hazardous depending on where they're located and what they're next to.

Optimizing for Safety: Finally, the tool uses all this information to create a plan for where to place each cargo unit on the ship deck. The goal is to find the arrangement that results in the lowest overall fire risk.

In summary, the tool uses the details about the cargo units and the ship deck and tries to find the safest way to organize the cargo.

Tasks

Please make your way through the prototype as you best see fit. Remember, these tasks are not a test of your skills, but a way for us to understand how the tool can be improved to better suit your needs. Please share your thoughts as you go through each task.

I may give instructions if there is a certain task, I want you to do on a certain page.

Instructions (optional – use the guide if the participant does not investigate on their own initiative)
1. Selecting a Cargo Unit: On your screen, you'll see a list of assigned cargo units. Please select a unit.
2. Pickup: When picking up your chosen cargo unit, please confirm the correct unit was selected.
3. Complete the fire hazard scan.
4. Cargo unit 2: Selecting a Cargo Unit: On your screen, you'll see a list of assigned cargo units. Please select a unit.
5. Pickup: When picking up your chosen cargo unit, please confirm the correct unit was selected.

6. Making Notes on Damage: If you notice any damage to the cargo unit, please record this. You'll see an option on the screen labelled "Report Damage." Touch that and enter your notes about the damage.
7. Complete the fire hazard scan.
8. Guidance to Correct Cargo Placement: The tool will guide you to where the cargo unit should be placed. Follow the instructions shown on the screen.
9. Confirming Cargo Placement: Once the cargo unit is in its assigned place, please confirm this. Press the "Confirm Placement" button on the screen to do so.
10. Requesting Alternative Placement: If you believe the cargo unit needs to be placed elsewhere, you can request an alternative placement.

11.2.2 Follow-up questions

The following general questions are intended to elicit responses about the tool's usefulness and effectiveness:

1. Was the information in the cargo list sufficient for selecting a cargo unit from the assigned list?
2. What was your opinion about the sequence confirming the pickup of the selected cargo unit?
3. How intuitive was the fire hazard scan process? Was there anything that you found confusing or difficult about it?
4. How could a fire hazard rating be useful in your work?
5. How easy or difficult did you find the damage reporting process? Would this be a useful feature?
6. How clear were the instructions for correct cargo placement? Was it easy to understand where to place the cargo?
7. Did the tool provide you with a clear and easy way to confirm the placement of the cargo unit?
8. In the case that the assigned cargo placement wasn't suitable, how straightforward was the process to request an alternative placement?
9. Were there any parts of the tool that you found frustrating, unrealistic, or difficult to use? If so, what improvements would you suggest?
10. How useful would this type of tool bel in your daily work, on a scale of 1-10, and why?
11. Overall, how would you rate the tool's user-friendliness? Why did you give it this rating?
12. Did you feel that using this tool helped improve the efficiency in loading? If so, how?
13. Were there any features that you wish the tool had? If so, what were they?

11.2.3 Planner Participant instructions Fire Hazard Optimisation tool

"Welcome and thank you for participating in this demonstration today. We're testing a tool designed to help plan stowage on ro-ro ferries and optimize it for minimum fire hazard. The Fire Hazard Optimization Tool plans the safest way to store cargo on a ship deck. Here's how it works:

Understanding the Cargo and Deck: The tool starts by looking at the cargo manifest, and the configuration of the ship deck.

Calculating Risk: Each cargo unit has a certain level of fire risk associated with it. This risk can be based on the type of cargo, how it's packaged, and other factors. The tool is based on research into real fires and the tool uses this information to figure out how risky each cargo unit is.

Considering Position: Not only does the tool consider the risk of each cargo unit, but it also considers where the cargo units are positioned on the deck, as well as the deck above and below. In addition, the location of stairs, ventilation etc are also considered. Some cargo units may become more hazardous depending on where they're located and what they're next to.

Optimizing for Safety: Finally, the tool uses all this information to create a plan for where to place each cargo unit on the ship deck. The goal is to find the arrangement that results in the lowest overall fire risk.

In summary, the tool uses the details about the cargo units and the ship deck and tries to find the safest way to organize the cargo.

During the test, we ask you to think aloud, meaning that you say whatever you're thinking and doing out loud. This will help us understand your thought process and user experience.

Let's start with the first task. Please find and click on the login button. Now that you're logged in, your next task is to select a departure, and remember to think aloud as you proceed.

Next, we'd like you to generate fire hazard ratings for a stowage plan. Please find this option and go through the process of generating these ratings, remember to think aloud as you do.

- Can you share your thoughts about the process?
- Also, was the visibility and interpretation of the fire hazard ratings clear?

The final task is to create an optimized stowage plan.

Now I'd like to ask about the sortable cargo list and the deck map.

- How useful did you find these features for your work?
- Could you share how you would typically use this type of information in your cargo planning process? Is there any information that you found missing or not easily accessible?

Now, let's talk about the cargo card that pops up when you click on a row in the cargo table.

- How useful did you find the information presented in this card?
- Were the tabs easy to navigate?
- And importantly, what information do you consider most relevant when planning cargo stowage, and was this easily accessible in the cargo card?

Now, I'd like to hear your overall thoughts about the tool.

- Do you have any suggestions for improving the tool?
- Now that you have interacted with the tool, how clear was it for you in understanding what the tool does and its purpose?
- Do you see this tool fitting into your current workflow? If so, how would it improve or change your current stowage planning process?
- Given that this tool provides fire hazard ratings and offers stowage optimization, how do you envision this impacting your daily work?
- Do you see any challenges in implementing this tool in your everyday work, or ways that it could particularly benefit your tasks?