A METHOD FOR ENABLING OPERATIONS ASSOCIATED WITH A SHIPMENT OF A CONTAINER AT A TERMINAL AND RELATED ELECTRONIC DEVICE

The present disclosure pertains to the field of transport and freight. The present disclosure relates to a method for enabling operations associated with a shipment of a container at a terminal and related electronic device.

BACKGROUND

Shipment of a container involves many operations, such as operations performed at a terminal. These operations for example include discharge of containers from a vessel, moving the discharged containers to a container yard, and loading a vessel with containers. Terminal equipment may for example be configured to carry out these operations. However, it may be appreciated that efficient execution of these operations is dependent on many variables. Furthermore, the efficiency of these operations may be interrelated, thereby increasing the complexity of the operations at the terminal.

SUMMARY

There is a need for an electronic device and a method that may predict operations in an upcoming time period in a given terminal, so as to determine performance metrics to achieve efficiency of operations at the terminal despite the complexity.

Accordingly, there is a need for an electronic device and a method for simulating one or more terminal operations associated with a shipment of a container at a terminal, which mitigate, alleviate, or address the shortcomings existing and may allow for an improved reliability, robustness, and/or efficiency of a control of operations associated with a shipment of a container at a terminal.

Disclosed is a method, performed by an electronic device, for enabling operations associated with a shipment of a container at a terminal. The method comprises obtaining input data associated with the shipment of the container and terminal data associated with the terminal. The method comprises simulating, based on the input data and the terminal data, one or more terminal operations. The method comprises determining, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment. The method comprises providing the one or more performance metrics.

Disclosed is an electronic device comprising memory circuitry, processor circuitry, and an interface, wherein the electronic device is configured to perform any of the methods disclosed herein.

Disclosed is a computer readable storage medium storing one or more programs, the one or more programs comprising instructions, which when executed by an electronic device (optionally with a display and a touch-sensitive surface) cause the electronic device to perform any of the methods disclosed herein.

It is an advantage of the present disclosure that the disclosed electronic device and method may enable an improved reliability, robustness, and/or efficiency of operations associated with a shipment of a container at a terminal.

An advantage of the present disclosure is that the disclosed electronic device and method may enable operations associated with the shipment of a container at a terminal to be predicted for a given future time period, e.g., for the next 24h, e.g. for the next 3 weeks. This may for example advantageously enable potential current and/or future problems, such as bottlenecks, associated with the operations to be identified and resolved before they occur. In other words, the disclosed electronic device and method may enable implementation of pre-emptive corrections to the operations associated with the shipment of a container at a terminal, e.g. in a planning phase.

A further advantage of the present disclosure is that the disclosed electronic device and method may enable optimisation of operations associated with the shipment of the container at the terminal. For example, the one or more performance metrics provided by the electronic device can be improved by iterating the simulation with updated input data until the performance metric(s) show satisfactory efficiency of the operations. Further, the disclosed electronic device and method may enable a comparison between operations indicated by the disclosed technique and actual operations during the shipment, which can allow for update or feedback to the simulation.

Furthermore, the input data and/or the terminal data, based upon which the one or more terminal operations are simulated, may be updated (e.g., by a user) to identify plans which enable an improved efficiency. Improved efficiency and optimized operations further enable in reducing energy consumption at the terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present disclosure will become readily apparent to those skilled in the art by the following detailed description of exemplary embodiments thereof with reference to the attached drawings, in which:

Fig. 1 is a diagram illustrating schematically an example simulation process where the disclosed technique is carried out by an example electronic device according to this disclosure,

Fig. 2 is an illustration of an example yard allocation at the terminal according to this disclosure,

Figs. 3A-C show a flow-chart illustrating an example method, performed by an electronic device, for enabling operations associated with a shipment of a container at a terminal according to this disclosure, and

Fig. 4 is a block diagram illustrating an example electronic device according to this disclosure.

DETAILED DESCRIPTION

Various exemplary embodiments and details are described hereinafter, with reference to the figures when relevant. It should be noted that the figures may or may not be drawn to scale and that elements of similar structures or functions are represented by like reference numerals throughout the figures. It should also be noted that the figures are only intended to facilitate the description of the embodiments. They are not intended as an exhaustive description of the disclosure or as a limitation on the scope of the disclosure. In addition, an illustrated embodiment needs not have all the aspects or advantages shown. An aspect or an advantage described in conjunction with a particular embodiment is not necessarily limited to that embodiment and can be practiced in any other embodiments even if not so illustrated, or if not so explicitly described.

The figures are schematic and simplified for clarity, and they merely show details which aid understanding the disclosure, while other details have been left out. Throughout, the same reference numerals are used for identical or corresponding parts.

A shipment may for example be seen as transportation of an item from a first location (e.g., origin) to a second location (e.g., destination), optionally via one or more intermediate locations. For example, the shipment may be seen as shipment of a container comprising the item, e.g., one or more goods. The one or more terminal operations can for example be seen as a part of the shipment.

A shipment can be associated with a consignee and a consignor. A consignee may be seen as the receiver of the shipped container. In other words, the consignee may be seen as a party responsible for accepting the delivery of the commodity (e.g., items) in the container. The consignee may for example be a party that has requested, such as booked, the shipment of the container. Consignee data is for example indicative of a consignee associated with the shipment. A consignor may be seen as the transporter (e.g., carrier) of the container. For example, the consignor may transport containers (e.g., comprising commodities) on behalf of a consignee. Consignor data is for example indicative a consignor associated with the shipment.

A container disclosed herein refers to a housing where items to be shipped are enclosed for transport. The term container may refer to one or more different container types and/or container sizes. For example, container types may include one or more of: dry container, refrigerated container, open top container, flat rack container, etc. For example, container sizes may include one or more of: 20-foot container, 40-foot container, etc.

The container for example comprises one or more items. An item disclosed herein refers to an object that is to be placed in a container for transport. For example, an item may be seen as an item of cargo, e.g. an item of freight, e.g. an object to be shipped. Note that the term item may be used interchangeably with cargo. For example, an item may comprise commodities that can be placed into containers, such as goods, such as consumer goods of large manufacturing corporations, generic consumer goods as shoes, clothing, toys and fast-moving-consumer-goods as packaged foods, beverages, toiletries, and medicines.

For example, the items disclosed herein may be seen as commodities that can be packed into e.g. rectangular stackable cartons with variable weights and volumes that are transported in one or more containers, such as dry containers and/or refrigerated containers.

A vessel may be seen as a vehicle performing the shipment. The vessel is for example a watercraft, such as a ship. The vessel may for example be a cargo ship, such as a container ship. For example, the vessel may ship one or more containers to and/or from the terminal. It may be appreciated that, in some examples, the vessel may be an aircraft and/or a land vehicle.

The terminal may be seen as a location where operations relating to discharging, such as offloading, containers off vessels and/or loading containers onto vessels. For example, a terminal may be seen as a location configured for the transfer of containers, such as between vessels and a container yard. The terminal may for example be seen as an origin location of a shipment and/or a destination location of a shipment and/or an intermediate location. Discharging a container from a vessel can for example be seen as offloading, unloading, and/or unlading a container from a vessel. The terminal may for example be a port. It may be appreciated that in some examples the term “terminal” may be used interchangeably with the term “port”.

A berth plan ensures that each vessel calling a terminal has a dedicated time slot and berth area, such as with a defined number of quay cranes or cranes. For example, a berth plan is seen as a plan to assign a space on a quay, and the unloading and/or unloading equipment to the vessel. In one or more embodiments, a vessel comprises a terrestrial vehicle. A berth plan may be seen the output of the berth scheduling. The berth plan can be seen as a plan to berth and process a pool of vessels arriving over time in a terminal. A berth plan can represent a schedule for one or more vessels calling a terminal (e.g. the one or more vessels having the terminal as the next stop) considering various constraints. A berth plan may comprise vessel data of a vessel, (such as one or more attributes associated with a corresponding vessel), an estimated time of arrival of the vessel, an estimated time of departure of the vessel, an information of its berth position given by the identification of a bollard. For example, the berth position may define where the vessel is to be moored on the quay. A berth plan may comprise a vessel information regarding its crane assignment. A crane assignment ensures enough quay cranes are available to unload and/or load items (e.g. discharge and load containers, and/or discharge and load of non-containerised goods) between the estimated time of arrival and departure of a vessel.

A yard as disclosed herein can for example be seen as a space in the terminal where container(s) are placed. For example, the yard can be seen as a container yard, such as a storage yard for one or more containers at a terminal. A container, such as a container offloaded by a vessel, may for example be allocated a storage space in the yard. In other words, the yard can be seen as a part, such as an area, of the terminal where containers are stored, such as between discharge and loading. An example a yard allocation of containers in a yard can for example be seen in Fig. 2.

Fig. 1 is a diagram illustrating schematically an example simulation process 2 where the disclosed technique is carried out by an example electronic device according to this disclosure. The example simulation process is carried out by an example electronic device, such as the electronic device disclosed herein, such as electronic device 300 of Fig. 4.

The electronic device is configured to obtain input data and/or terminal data from one or more data sources: For example, the data sources comprise one or more of: a berth planner system 55, a booking system 56, a database 57, a Terminal Operation System 58, and relevant terminal specific data sources, such as yard map database(s) 59. The database 57 for example stores information of assets and/or equipment of the terminal, including operating status. For example, the database 57 may comprise information regarding the quay cranes, the gantry cranes and/or the trucks.

Fig. 1 illustrates a timeline 20, where the timeline 20 is indicative of an example chronological order in which steps 22-54 on the timeline are to be carried out, e.g., by the electronic device.

The timeline 20 comprises steps 22, 24, 26, 30, 40, 52, and 54. Step 30 comprises steps 32, 34, 36, and 38. Step 40 comprises steps 42, 44, and 46.

The steps of example simulation process 2 may for example be seen as one or more terminal operations. The steps 22-54 are for example associated with a given time, such as a time and/or time-period indicative of a simulated terminal operation start, terminal operation end, and/or terminal operation period, where the terminal operation period can for example be seen as indicative of the time taken for a given operation, such as step, to be carried out. In some examples, Fig. 1 shows a “flow” as series of processes (or steps) that a token can take in the simulation. A token can be seen as an element of the simulation that is representing an object (such as an item, such as a physical item, such as a vessel) so that operations and/or a series of processes (e.g. a flow of process) can be associated to it and/or monitored. For example, a token is simulated to move through the process following a sequence of processes, operations and/or decisions. For example, in a berth flow illustrated by step 24, a token is representative of a vessel. For example, in a Discharge and Loading Flow illustrated by steps 30 and 40 respectively, a “token is representative of a container.

The steps shown in Fig. 1 may for example be seen as operations, such as terminal operations, associated with a shipment of a container at a terminal. In one or more examples, the electronic device may simulate one or more of the steps of example simulation process 2, such as the one or more terminal operations. Simulating the steps 22-54 for example comprises simulating a time taken to perform one or more of steps 22-54.

Step 22 for example comprises simulating the scheduled arrival of a vessel at the terminal. In some examples, the arrival time of the vessel may be obtained, such as retrieved and/or received from a berth planning system. In some examples, step 22 may comprise simulating, such as predicting, the arrival time of a vessel at the terminal.

Step 24 represents the berth flow simulation. For example, the berth flow simulation models the flow of vessels through the terminal. For example, this is entry point of the simulation, and each vessel is a token in step 24. Step 24 includes for example; the vessel arriving, when the vessel token arrival time is met, and berthing.

At step 24, the electronic device for example simulates a request for berth by the vessel and optionally a time that the vessel waits, e.g., after arrival at the terminal but not at a quay (e.g. within a port or nearby a port), to be allocated a berth. For example, the vessel may wait until a different vessel occupying its allocated berth departs from the terminal, thereby vacating the allocated berth for the vessel associated with the shipment. For example, at step 24 the electronic device may simulated the vessel waiting until one or more bollards associated with the allotted berth at the terminal are available for line attachment.

A vessel is allocated a berth at a terminal, such as a space on a quay at a dock of a terminal. The berth that is allocated to the vessel associated with the shipment can for example be seen as a designated and/or allotted berth of the terminal. The allocated berth may for example be pre-determined, such as determined using a berth planning system. The electronic device may for example be configured to obtain, such as receive and/or retrieve as part of the terminal data, berth planning data indicating the allocated berth from the berth planning system.

At step 26, the electronic device for example simulates the berthing of the vessel until berthing of the vessel at its allocated berth is complete. Completing the berthing of the

vessel at the allocated berth for example comprises all ropes, such as lines, being attached between the vessel and the terminal, such as one or more bollards of the terminal. In other words, at step 26 the electronic device may simulate the berthing until all ropes of the vessel may be attached to the bollards of the terminal. Berthing of the vessel for example comprises a period from a first line being cast from the vessel to all lines being fast, such as secured, at the terminal, such as secured to one or more bollards at the terminal. In some examples, the time taken for berthing of the vessel is a (pre-) determined time period, e.g., one hour, as provided by the berth planning data.

Step 26 is seen as e.g. initialising step the discharge flow (Step 30) and then the loading flow (Step 40). For example, once the loading flow (step 40) is complete, the vessel can depart.

Step 30 can for example comprises the discharge, such as unloading (e.g. start of unloading or discharge flow), of one or more containers from the vessel at the terminal. Step 30 can for example be seen as a discharge flow of the simulation. Step 30 comprises simulating steps 32, 34, 36, and 38. Step 30 for example comprise one or more terminal operations. The discharge flow for example considers each container as a token. Step 30 simulates the journey that each container makes from the vessel to their stack in a yard. Step 30 or flow is started in the simulation from the success hook in the "WaitForFirstCrane" process from the berth flow. For example, when all containers are discharged, a vessel indicator: "Discharge" is set to True which the process "Discharge" is waiting for so that the next step can be initiated: "StartLoadingToken" which starts the loading flow (Step 40). Step 40 for loading for example comprise one or more terminal operations.

Step 32 for example comprises taking into account a time at which berthing of the vessel at its allocated berth is complete. Step 34 for example comprises simulating discharging, such as using one or more cranes (such as quay cranes and/or gantry cranes) one or more containers from the vessel, such as from the berthed vessel (e.g. crane discharge step). Step 36 comprises simulating transferring of one or more containers to a truck for transport to the container yard (e.g. truck to transit step) and/or to a Rubber Tyred Gantry (RTG) crane. Step 36 for example comprises simulating the transporting, e.g., using the truck, of one or more discharged containers to the container yard for storage of the one or more containers. Step 38 for example comprises simulating: transferring the one or more containers, e.g., from the truck to an allocated container space in the container yard (e.g.

container storing step). In some examples, step 38 comprises transferring, e.g., using a gantry crane, for example, a Rubber Tyred Gantry (RTG) crane, one or more discharged containers to the container yard to their allocated container space in the container yard, e.g., to a space in the container yard allocated to a given container (as indicated in Fig. 2). The RTG crane can for example be seen as a container yard crane, such as a crane for transferring a container from a truck to the container yard or from the container yard to the truck. The quay crane and/or gantry crane can for example be seen as a crane for moving a container to and/or from a berthed vessel and a truck at the terminal.

Step 40 can for example comprises the loading of one or more containers to the vessel at the terminal. Step 40 can for example be seen as a loading flow of the simulation. Step 40 comprises simulating steps 42, 44, and/or 46. Step 40 for example comprises simulating one or more terminal operations. For example, the loading flow has each container as a token. For example, the loading flow simulates containers being loaded onto the vessel from their stack in the yard. For example, the loading flow repeats for each token (e.g. each container) until a part or all containers are loaded for completion. For example, a part of the containers may be sufficient for proceeding to the next step. For example, when the loading of the containers is completed, the vessel indicator may be updated to indicate that loading is completed, which enables the vessel token to pass through the next process in the berth flow. For example, when all containers are loaded, the vessel indicator may change its status to indicate that loading is completed, which enables the vessel token to pass through the next process in the berth flow.

Step 42 for example comprises simulation of extracting of a container, e.g., using an RTG crane, from a yard block (e.g. container extraction step). Step 44 for example comprises simulation of the transferring, e.g., using an RTG crane, of one or more containers from their allocated container space in the container yard to a truck (e.g. truck transit step) towards a crane. For example, step 44 comprises simulating: transporting one or more containers, e.g., using a truck, from the container yard to the vessel, such as to an area of the terminal near the vessel so that a crane can handle the container in step 46. Step 46 for example comprises simulating: loading, such as using one or more cranes, one or more containers to the vessel, such as to the berthed vessel (e.g. crane loading process). For example, step 46 comprises loading one or more containers from a truck to the berthed vessel.

At step 52, the simulation includes simulating that the vessel may initiate departure from its allocated berth. Step 52 comprises simulating the time taken for the vessel to detach, such as unberthing, from its allocated berth space. Detachment of the vessel from the allocated berth for example comprises detaching all ropes, such as lines, of the vessel from the bollards at the terminal. In other words, the step 52 may be indicative of a time taken between loading of the final container is complete and when the last line securing the vessel to a bollard of the terminal is detached. In some examples, the time period of step 52 between when loading of the final container is complete and when the last line securing the vessel to the terminal is detached is for example a pre-determined time period, e.g., one hour.

Step 54 is for example associated with simulating a scheduled departure time of a vessel at the terminal. The scheduled departure time of the vessel may for example be obtained, such as retrieved and/or retrieved from the berth planning system. In some examples, step 54 comprises simulating a departure time of a vessel at the terminal. In some examples, there may be time period, e.g., 1 hour, after the departure of a vessel from a berthing space where the berthing space may not be used by another vessel.

Fig. 2 is an illustration of an example yard allocation 60 at the terminal according to this disclosure. Fig. 2 for example shows an example allocation of containers in a yard at a terminal. The containers shown in Fig. 2 are for example associated with the shipment.

The yard allocation 60 represents an example yard allocation of containers. The yard allocation 60 can for example be seen as a yard allocation provided by the simulation, such as simulated state of a yard allocation at a container yard of the terminal. For example, the yard allocation 60 can be seen as a representation of a predicted yard allocation for a given moment in time, such as an upcoming period.

The container yard comprises one or more containers, such as containers being stored in their allocated spaces. In some examples, the simulation can include a scenario where a crane (e.g., an RTG crane) has performed an operation to move the containers to their allocated spaces corresponding to the yard allocation 60.

The yard allocation 60 comprises container spaces 62-92. Container spaces 62-92 can for example be seen as container slots of the yard allocation 60.

The yard allocation 60 comprises one or more empty spaces 62, such as yard allocation spaces (e.g., slots) not having a container. The empty spaces 62 are for example indicated by a rectangle not comprising a pattern.

Container spaces 62-92 show container spaces comprising different types of containers, where the fill pattern of each container illustrates each container type.

As illustrated by container spaces, 72, 80, 76, 82, 86, and 89, one container space may be allocated for two containers, e.g., two 20-foot containers.

A yard allocation of containers can also be used as terminal data to be input into the simulation. For example, the yard allocation data provided as terminal data to the simulation can include data indicative of simulated yard allocation(s) and/or data indicative of actual yard allocation(s) (e.g. previously allocated).

Figs. 3A-C show a flow diagram of an example method, performed by an electronic device, for enabling operations associated with a shipment of a container at a terminal, according to the disclosure. The method 100 can be performed for improving operations associated with a shipment of a container at a terminal. The method 100 can be performed for managing and/or controlling operations associated with a shipment of a container at a terminal. The disclosed method can be for example be performed for simulating operations associated with a shipment of a container at a terminal.

The one or more operations associated with a shipment of a container at a terminal may for example be performed by terminal equipment, and/or any other type of equipment and/or terminal operator(s). The operations for example comprise movement of a container at a terminal, such as a terminal where the vessel performing the shipment of the container is berthed. For example, the operations may comprise one or more of: berthing of the vessel, attaching lines of the vessel to the terminal, discharging a container from a vessel, moving a container to and/or from an allocated space in the yard, loading the container onto the vessel, detaching lines of the vessel from the terminal, and/or departure of the vessel from the terminal.

The method 100 is performed by an electronic device, such as the electronic device disclosed herein, such as electronic device 300 of Fig. 4. In some examples, the electronic device is for example a user device for planning terminal operations. In some examples, the electronic device is for example a part of a Terminal Operation System

(TOS). In some examples, the electronic device is a part of a system comprising one or more distributed control systems.

The method 100 comprises obtaining S102 input data associated with the shipment of the container and terminal data associated with the terminal. In some examples, obtaining S102 input data associated with the shipment of the container and terminal data associated with the terminal comprises receiving and/or retrieving input data associated with the shipment of the container and terminal data associated with the terminal, e.g. from one or more data sources. For example, the data sources comprise one or more of: a berth planner system, a booking system, a database storing information regarding equipment and/or assets, a TOS, and relevant terminal specific data sources, such as yard map database(s) (as illustrated in Fig. 1).

In some examples, obtaining S102 input data associated with the shipment of the container and terminal data associated with the terminal comprises generating input data associated with the shipment of the container and terminal data associated with the terminal.

The input data and/or terminal data may for example be obtained periodically, such as from a database associated with the shipment, such as associated with the terminal. The input data and/or terminal data may for example be obtained at any frequency, e.g., every 5 minutes, every hour, every 2 hours, every day, etc. The input data and/or terminal data may for example be manually updated, such as refreshed. The input data and/or terminal data provided for the simulation may for example be updated based on a user input to the simulation and/or based on previous actual shipment of container(s) and/or previous actual terminal data. The input data for example comprises a time period parameter. The time period parameter is for example indicative of a time period in the future to be simulated, e.g., one or more days, weeks, months, etc. In other words, the time period parameter is for example indicative of a simulation length, e.g., 24 hours. The input data may for example comprises a convoy window time. The convoy window time is for example indicative of a time window within which a vessel may pass through a given area, e.g., the Suez Canal.

In one or more example methods, the input data comprise one or more of: vessel data, container data, and voyage data. In some examples, the vessel data for example comprises one or more of: a vessel identifier data, a vessel type data, vessel dimension

data, vessel equipment data for loading/unloading. The vessel identifier data may example be indicative of the vessel. For example, the vessel identifier data may comprise a code, such as an alphanumeric code indicative of the vessel, such as a vessel associated with the shipment. The vessel identifier data may for example be indicative of the number of containers and/or weight of the containers being shipped by the vessel. The vessel type data is for example indicative of a type of vessel. For example, the vessel type data may be indicative of a class and/or category of a vessel. For example, the vessel data may indicate that the vessel is a cargo ship (such as a container ship), a barge, a ferry, etc. The vessel dimension data is for example indicative of the dimensions of the vessel, such as the vessel associated with the shipment. The vessel dimension data is for example indicative of the length, height, and/or width of the vessel.

The vessel equipment data is for example indicative of equipment associated with the vessel. In some examples, the vessel equipment data may be indicative of one or more cranes of the vessel, such as a crane of the vessel configured for discharging a container from the vessel. For example, the vessel equipment data may be indicative of a deck crane of the vessel, such as the number of deck cranes associated with the vessel.

In some examples, the container data comprises one or more of: container type data, container size data, commodity type data, etc. Container type data is for example indicative of a type of container. For example, the container type data may comprise information indicative of one or more of: dry container, refrigerated container, open top container, flat rack container, etc. The container size data is for example indicative of a size of a container. The container size data may for example be indicative of the dimensions of the container. For example, the container size data may be indicative of the length, height, and/or width of the container. For example, the container size data may be indicative of one or more of: 20-foot container, 40-foot container, etc. The commodity type data is for example indicative of a type of commodity associated with the shipment, e.g., being shipped. In some examples, the commodity type data comprises a code, such as an alphanumeric code indicative of the commodity type. In some examples, the commodity type data comprises a Harmonized System (HS) code indicative of a commodity type, such as a category of commodity.

In some examples, the voyage data comprises one or more of: origin location data, destination location data, intermediate hub data, inland delivery location data, consignor data, consignee data, etc. A shipment can for example be seen as comprising an origin

location, such as a first location, and a destination location, such as a second location. For example, when a vessel ships a container from a terminal in Dubai, the first location, to a terminal in Copenhagen, the second location, then Dubai may be seen as the origin location, and Copenhagen may be seen as the destination location. Origin location data is for example indicative of the origin location of the shipment. Destination location data is for example indicative of the destination location of the shipment. The shipment may for example comprise an intermediate hub. For example, the intermediate hub may be seen as an intermediate location, such as an intermediate terminal. The vessel carrying out the shipment may for example berth at one or more intermediate hubs during a shipment. In some examples, one or more containers may be discharged and/or loaded during berthing at the intermediate location. The intermediate location data is for example indicative of the location of the intermediate hub. In some examples, the intermediate hub data may be indicative of one or more operations associated with the shipment of a container at the intermediate hub. The inland delivery location data may for example be indicative of an inland delivery location, such as an inland location where one or more goods associated with the shipment are to be delivery. The inland location may for example be a storage facility, a warehouse, a distribution facility, etc.

In some examples, input data may for example be associated with a booking. For example, the vessel data, the container data, and the voyage data may be associated with a booking. For example, the input data associated with a booking may be provided, e.g., via a booking platform, by a user (such as a consignee).

In one or more example methods, the terminal data comprise one or more of: berth planning data, terminal equipment availability data, terminal equipment allocation data, yard data, yard allocation data, and yard inventory data. The berth planning data is for example indicative of one or more berth plans associated with a terminal. For example, the berth planning data may be indicative of one or more allocated berths for vessels at a terminal. In some examples, the berth planning data for example comprises actual data, such as actual berth planning data, such as historical berths and/or planned upcoming berths at a terminal. The berth planning data may for example be obtained from a berth planning system. For example, when a berth plan has been carried out successfully, the berth plan can be added to a berth master plan which is stored in the berth planning system and can be provided as berth planning data.

The terminal provides terminal equipment that can be used for terminal operations. Terminal equipment for example comprises one or more cranes (e.g., quay cranes, gantry cranes, automated gantry cranes, automated stacking cranes), one or more shuttle carriers or straddle carriers, one or more vehicles (e.g. trucks), one or more automated guided vehicles, etc, associated with the terminal. The terminal equipment may for example be seen as equipment located at a terminal and configured to move one or more containers associated with a shipment. The terminal equipment for example comprises a crane, such as a Rubber Tyred Gantry (RTG) crane, a quay crane, a gantry crane, a mounted gantry crane, and/or any other suitable types of cranes. The RTG crane is for example configured to move one or more containers to and/or from a container yard. The RTG may for example be configured to move one or more containers between a vehicle, such as a terminal vehicle, and the container yard. The RTG crane may for example be configured to move a container between one or more spaces in the container yard. For example, the RTG crane may move a container between one or more blocks, e.g., sections, of the container yard. The quay crane and/or gantry crane is for example configured to move one or more containers to and/or from the vessel. For example, the quay crane and/or gantry crane may be configured to discharge one or more containers from the vessel. The quay crane and/or gantry crane may for example be configured to load one or more containers onto the vessel. In some examples, the quay crane and/or gantry crane is configured to move one or more containers between the vessel and a vehicle, such as a terminal vehicle for transport of the container to an RTG crane where the RTG crane may move the container to an allocated position in the container yard. When the vessel is berthed at the terminal, any equipment of the vessel may, in some examples, be seen as terminal equipment.

In some examples, the terminal equipment comprises one or more of: quay crane, gantry crane, RTG crane, luffing crane, ship to shore (STS) crane, mobile harbour crane, and a transportation vehicle. The transportation vehicle, such as one or more transportation vehicle, may for example be a truck, a car, a lorry, a flatbed, etc. The type of terminal equipment, such as crane, vehicles, etc, is not limiting.

The terminal equipment availability data is for example indicative of the availability of one or more units of terminal equipment, such as cranes and/or vehicles. For example, the terminal equipment availability data may be indicative of whether a unit of terminal equipment, such as a crane, has capacity to perform an increased number of operations.

For example, the terminal equipment availability data may be indicative of terminal equipment not performing operations for a given period of time, such as an idle time period of the terminal equipment.

The terminal equipment availability data may for example be indicative of a ratio between one or more terminal equipment types available. For example, the terminal equipment availability data may be indicative of a terminal equipment ratio, where the terminal equipment ratio is a ratio between a number of different types of terminal equipment available vs occupied, such as types of available terminal equipment.

In some examples, the method 100 comprises selecting, based on the terminal equipment availability data, terminal equipment to carry out one or more operations associated with the shipment at the terminal in the simulation S108.

The terminal equipment allocation data is for example indicative of the allocation of one or more units of terminal equipment. The terminal equipment allocation data may for example be indicative of one or more operations allocated to a given unit of terminal equipment.

The yard data is for example indicative of a layout of a yard of the terminal for placing containers, such as the container yard. For example, the yard data may comprise a map of the terminal. For example, the yard data may comprise a map of the container yard. The yard data may for example comprise information indicative of the locations and/or routes of the terminal equipment. For example, the yard data may be indicative of one or more discharge and/or loading routes associated with a berth at the terminal. The yard data is for example indicative of an area in the yard which a crane (e.g., an RTG crane) may perform operations in, such as move containers in. For example, the yard data may be indicative of one or more blocks, columns, stacks, etc, of containers in the yard that a unit of terminal equipment, such as an RTG crane, may perform operations on.

The yard allocation data is for example indicative of an allocation of containers in the yard. For example, the yard allocation data may be indicative of one or more allocated spaces in the yard for one or more containers at the terminal. In other words, the yard allocation data may be indicative of a space in the yard that is allocated to a given container at the terminal. The yard allocation data may for example be indicative of a number of spaces available for containers. In some examples, the yard allocation data comprises

information indicative of a yard allocation, such as yard allocation 60 shown in Fig. 2. For example, the yard allocation data comprises information indicative of an actual yard allocation. The electronic device may for example be configured to obtain the yard allocation data, e.g., via a user input. In some examples, the yard allocation data may be indicative of a state of allocation of the container yard, e.g., such as a current or historical state of allocation of the container yard. In some examples, the yard allocation data may be indicative of a pre-determined, such as default, state of allocation of the container yard.

The yard inventory data is for example indicative of the number of units of terminal equipment for placing container(s) in the yard, such as the number of units of a type, such as each type, of terminal equipment.

The method 100 comprises simulating S108, based on the input data and the terminal data, one or more terminal operations. In one or more example methods, simulating S108, based on the input data and the terminal data, one or more terminal operations comprises simulating S108, based on the input data and the terminal data, one or more terminal operations by applying a simulation technique to the input data and/or the terminal data. In one or more example methods, the simulation technique is a discrete event simulation technique.

The one or more terminal operations may for example be performed by terminal equipment. The terminal operations for example comprise movement of a container at a terminal, such as a terminal where the vessel performing the shipment of the container is berthed. For example, the terminal operations may comprise one or more of: discharging a container from a vessel, moving a container to and/or from an allocated space in the yard, loading the container onto the vessel, berthing of the vessel, and departure of the vessel. In one or more examples, the simulation S108 can take as input previous, such as historic, terminal operations, and/or user input indicative of a terminal operation selected by a user for simulation.

The method 100 comprises determining S110, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment. The one or more performance metrics are for example indicative of a performance of the terminal operations at the terminal. For example, the one or more performance metrics may be indicative of the efficiency of one or more terminal operations at the terminal. The one or more performance metrics may be indicative of the efficiency of the terminal

equipment and/or terminal operators. In one or more example methods, the one or more determined performance metrics comprise one or more of: terminal equipment performance parameter, a crane intensity parameter, a port movement parameter, a container movement parameter, a crane movement parameter, a crane lift parameter, a rope attachment parameter, and a last line removal parameter. The terminal equipment performance parameter is for example indicative of the performance of a given type of terminal equipment, such as a crane (e.g., an RTG crane, a quay crane), a truck, etc. In some examples, the terminal equipment performance parameter may be indicative of the performance of a given unit of terminal equipment. In some examples, terminal equipment performance parameter may be indicative of the movement, such as the distance travelled per unit time, of a terminal equipment (e.g., of a type and/or unit of terminal equipment.

A time period in which one or more cranes of the terminal equipment may lift a container may be seen as a lifting period. In some examples, the lifting period can be seen as an active period of a crane, such as a non-idle period. The crane intensity (CI) parameter is for example indicative of the time that a crane spends carrying out operations. For example, the crane intensity parameter may comprise a ratio between the time spent by a crane performing operations and the lifting period, such as the total time which a crane could be performing operations. In other words, the CI parameter may be indicative a proportion of idle time associated with a crane, such as a proportion of the crane's time which is not being spent performing operations. The CI parameter can for example be seen as a simulated CI parameter. A planned CI parameter may for example be obtained from a berth planner system. The determined CI parameter may for example be simulated based on the crane assignments per shift and may be calculated accordingly per vessel. The determined CI parameter may for example include information indicative of a difference one or more CI parameters.

The port movement parameter is for example indicative of a number of movements performed in a terminal over a given time period, such as over the lifting period. The port movement parameter may for example be indicative of the total number of terminal equipment movements, performed in a terminal per hour, such as number of crane lifts per hour during the lifting period. In other words, the port movement parameter may be indicative of the total number of terminal equipment movements per unit time, e.g., per hour, during operational hours of one or more cranes and/or trucks at the terminal. A

terminal equipment movement may for example comprise one or more of: unloading a container from a vessel to a vehicle, transporting the container (e.g., such as using a vehicle, such as a truck) to and/or from the allocated container space at the yard, loading the container onto the vessel, and/or moving a container from one space in the container yard to another space in the container yard.

The container movement parameter is for example indicative of the movement of a container, such as for a given time period. For example, the container movement parameter may be indicative of a number of movements of one or more containers, such as all containers, at the terminal, e.g., per unit time. For example, the container movement parameter may be indicative a number of container discharge moves at the terminal. The number of discharge moves of a container can for example be seen as the number of moves, such as operations, over a period of time associated with moving a container from the vessel to the allocated space for that container in the container yard. For example, the container movement parameter may comprise a total number of moves, such as total number of moves for all shipments at the terminal over a period of time associated with moving a container from the vessel to the allocated space for that container in the container yard. For example, the container movement parameter may be indicative a number of container loading moves at the terminal. The number of loading moves of a container can for example be seen as the number of moves, such as operations, over a period of time associated with moving a container from its allocated space at the container yard to the vessel. For example, the container movement parameter may comprise a total number of moves, such as total number of moves for all shipments at the terminal over a period of time associated with moving a container from its allocated space at the container yard to the vessel. The container movement parameter may for example comprise one or more container movement parameters for “full” containers, where a full container can be seen as a container that is not empty. The container movement parameter may for example comprise one or more container movement parameters for empty containers, such as containers not comprising any items. In some examples, the container movement parameter may be indicative of the movement, such as the distance travelled per unit time, of one or more containers at the terminal.

The crane movement parameter is for example indicative of a number of movements performed by a crane at the terminal. In some examples, the crane movement parameter comprises crane moves per unit time, such as per hour. A crane move can for example be

seen as an operation performed by the crane, e.g., such as moving a container from the vessel to the container yard. A crane move may for example comprise moving, such as transporting a container, between one or more blocks, such as sections, of the container yard, such as an inter-block movement. For example, crane moves per unit time may be determined by dividing number of cranes moves by the crane utilized time, where Crane Utilised Time can be seen as the aggregated active (such as non-idle) time of all cranes assigned to the vessel. The crane movement parameter for example comprises a parameter indicative of Gross Crane Working Hours, such as total active time of all cranes at the terminal for a given time period.

The crane lift parameter is for example indicative of a number of lifts, such as container lifts, performed by a crane at the terminal. For example, the crane lift parameter may be indicative of number of crane lifts, such as of a container, per unit time. In some examples, the crane lift parameter is indicative of Crane Lifts per Hour (CLPH). In some examples, a crane may lift one or more, such as two, containers in a single lift. In some examples, 20-foot containers lifted by a crane at the same time, may be counted as 2 separate lifts, rather than 1 lift.

The rope attachment parameter may for example be indicative of a simulated time from a vessel entering the terminal or port to when all ropes, such as lines, of the vessel are fastened (e.g., attached) at the allocated berth. In other words, the rope attachment parameter may be indicative of a time when berthing of the vessel is complete, e.g., all ropes of the vessel required to be attached, such as attached to the bollards of the terminal, for berthing to be complete have been attached. The rope attachment parameter can for example be seen as indicative of a time when the vessel is secured to the dock, such as secured to the terminal.

The last line removal parameter may for example be seen as a time or event when all ropes are removed such that the vessel may depart from the terminal. In other words, the last line removal parameter may be indicative of a time when all lines of the vessel have been successfully detached e.g., from bollards, at the terminal.

The method 100 comprises providing S116 the one or more performance metrics. In some examples, providing S116 the one or more performance metrics comprises displaying a user interface object representative of the one or more performance metrics.

In some examples, providing S116 the one or more performance metrics comprises reporting and/or sending the one or more performance metrics, e.g., to a user device.

In one or more example methods, the method 100 comprises generating S122, based on the one or more determined performance metrics, control data for controlling an operation associated with the shipment. Control data can for example be seen as data, based upon which an operation (such as terminal equipment) can be controlled. In one or more example methods, the method 100 comprises controlling S124, based on the control data, an operation associated with the shipment. Controlling S124 an operation associated with the shipment for example comprises providing, such as sending, control data to terminal equipment and/or a user device so as to cause the operation to be carried out. In some examples, controlling S124 an operation associated with the shipment comprises providing, such as transmitting, a control signal indicative of the control data to terminal equipment and/or a user device causing the operation to be carried out.

In some examples, the method 100 comprises updating, e.g., based on the control data, such as a control signal, the input data associated with shipment of the container and/or terminal data associated with the terminal. For example, the control data comprises updated yard allocation, such as the yard allocation 60 shown in Fig. 2.

In one or more example methods, the method 100 comprises obtaining S104 historical data indicative one or more of: one or more historical shipments, historical Berth planning, and one or more historical terminal operations. The historical data can for example be seen as actual data, such as actual historical data. The one or more historical shipments can for example be seen as one or more actual historical, such as previously occurring, shipments associated with a container at the terminal. The historical berth planning can for example be seen as one or more actual historical, such as previously occurring, berth plans associated with one or more shipments of containers at the terminal. The one or more historical terminal operations can for example be seen as one or more actual historical, such as previously occurring, terminal operations associated with a container at the terminal. For example, the historical data may comprise information indicative of actual historical operations at the terminal for a given previous time period, e.g., last 2 months. In some examples, the historical data comprises Internet of Things (IoT) cycle data associated with one or more historical operations performed by the terminal equipment. The historical data for example comprises a cycle time, such as a cycle time indicative of a time between berthing and departure of a given vessel at the terminal. For

example, the cycle time may be an average cycle time for given time period. In some examples, the historical data comprises information indicative of one or more historical performance metrics. In some examples, the historical data comprises information indicative of the speed and/or efficiency of terminal equipment associated with one or more historical operations at the terminal.

In one or more example methods, simulating S108, based on the input data and the terminal data, the one or more terminal operations comprises generating S108A, based on the input data and the terminal data, (and optionally based on the historical data), a distribution indicative of historical terminal operations. For example, the electronic device may generate the distribution of historical terminal operations (such as terminal operation in the previous X months, where X is a positive integer) and use the generated distribution to simulate the terminal operations based on the input: input data and terminal data. The distribution can provide distribution of various performance metrics over time.

The distribution can be seen as a function of the terminal operations over time, such as distribution of various performance metrics over time for each terminal equipment.

The generated distribution may advantageously enable non-linear effects associated with operations at the terminal to be simulated, e.g., with an improved accuracy. In some examples, generating S108A the distribution comprises generating, based on actual historical data, a distribution of terminal operations over time. It may be appreciated that as the distribution is generated based on actual data, which is non-linear, the non-linear effects are accounted for. Generating S108A the distribution for example comprises generating, based on one or more assumptions (e.g., approximations), the distribution. For example, the one or more assumptions may comprise assuming that any quay crane and/or gantry crane can reach any place in the ship. By generating the distribution based on the one or more assumptions, the distribution may be generated to a satisfactory accuracy while for example minimizing the complexity of the simulation, thereby reducing the computational load on the electronic device and/or reducing the time taken for the electronic device to perform the simulation. In some examples, the distribution is indicative of the cycle time for one or more operations performed by the terminal equipment (e.g., a crane) at the terminal.

In one or more example methods, simulating S108, based on the input data and the terminal data, the one or more terminal operations comprises predicting S108B, based on

the distribution, one or more terminal operations. In some examples, predicting S108B the one or more terminal operations for example comprises predicting the one or more terminal operations, such as by sampling from the historical data, such as actual historical data corresponding to the input data and terminal data. In one or more examples, the input data comprises a simulation period. The simulation period is for example indicative of a time period for which the operations associated with the shipment of a container at a terminal are to be predicted.

In one or more example methods, simulating S108 the one or more terminal operations comprises determining S108C a route to a yard allocation for the container, and terminal equipment associated with carrying out the route, by applying S108CA a routing technique to one or more of: the input data, the terminal data, and the historical data. The route can for example be seen as a path, e.g., a path taken by terminal equipment. For example, the route may be a path taken by a truck when transporting a container to and/or from the vessel and the yard, such as a container yard (e.g., to an allocated space for a container in the yard). In some examples, determining S108C terminal equipment associated with carrying out the route comprises selecting a unit of terminal equipment (e.g., an optimal unit of terminal equipment) to carry out the route, such as to carry out an operation associated with the route, such as a truck, a crane, etc.

The routing technique may for example comprise applying a routing algorithm, e.g., to one or more of: the input data, the terminal data, and/or the historical data. The routing technique may for example comprise determining the shortest path to a yard allocation for a given container. For example, the routing technique may comprise the shortest route for a crane discharging one or more containers from a vessel at the terminal and to a truck, to a yard allocation. In some examples, the routing algorithm comprises a shortest path algorithm, e.g., with some additional consideration such as weighting of a move and/or route. The shortest path may for example be configured to determine, e.g. based on the input data, the terminal data, and/or the historical data, a shortest path for a given operation, such as container movement, at the terminal. In some examples, the shortest path may for example be configured to determined, e.g. based on the input data, the terminal data, and/or the historical data, a total shortest path for one or more, such as all, operations at the terminal, e.g., for a given period of time. In some examples, the routing technique comprises weighting one or more routes and/or units and/or types of terminal equipment. For example, one or more gantry moves, such as routes to be taken by a

gantry crane, may be weighted higher, e.g., due to inefficiency. In some examples, one or more gantry moves may be weighted lower, e.g., fast moves and/or moves required less weight to be moved may have a lower weighting.

In some examples, the routing technique may determine a time taken for a unit of terminal equipment (e.g., truck and/or RTG crane) to move along a given route of the terminal. In some examples, determining S108C a route to a yard allocation for the container, and terminal equipment associated with carrying out the route comprises determining S108C a route to a yard allocation for the container, and terminal equipment associated with carrying out the route by applying S108CA a routing technique to one or more of: the input data, the terminal data, the historical data, and constraint data (e.g., indicative of one or more constraints). For example, the constraint data may be indicative of a one-way system, such as a one-way route.

In one or more example methods, determining S110, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment comprises predicting S110A, based on the one or more simulated terminal operations and/or based on the distribution, one or more performance metrics. For example, predicting S110A one or more performance metrics comprises predicting one or more performance metrics for an upcoming time period, e.g. next 24 hours, next week, next 2 weeks, etc.

In one or more example methods, the method 100 comprises determining S106, based on the input data and/or the terminal data, constraint data indicative of one or more constraints associated with the shipment and/or the terminal. The one or more constraints can for example be seen as constraints, e.g., rules, to be respected. In some examples, the one or more constraints can be seen as rules which the operations associated with the shipment may not breach, such as deviate from. In some examples, the one or more constraints may be terminal specific. In other words, the constraint data may be associated with the terminal. The constraint data can for example be seen as data indicative of one or more constraints associated with the shipment of the container at the terminal. For example, the constraint data may be indicative of one or more areas of the yard where one or more containers, such as types of containers, are restricted from being stored in. For example, one or more allocated spaces in the yard may not be allocated to one or more types of container, such as containers comprising dangerous goods, e.g., explosive materials, hazardous materials, etc. In some examples, the constraint data is

indicative of one or more physical constraints, such as physical limitations, e.g., of the terminal equipment. In some examples, the constraint data may be obtained, e.g., from container data, (e.g. the content of the container), e.g. from a booking system and/or from a user. In some examples the constraint data may be received and/or retrieved, e.g., from container data, (e.g. the content of the container), e.g. from a booking system and/or from a user. In some examples, the constraint data may be generated, e.g., based on a user input.

In one or more example methods, the method 100 comprises determining S112, based on the one or more predicted performance metrics, bottleneck data indicative of a bottleneck of one or more operations associated with the shipment of a container at a terminal. The bottleneck of one or more operations can for example be seen as a set of operations causing a delay in any step of the shipment (such as any steps illustrated in Fig. 1). For example, the bottleneck can be seen as a congestion of one or more operations associated with the shipment of a container at a terminal. The bottleneck may for example be associated with one or more capacity issues at the terminal, such as insufficient availability of terminal equipment for carrying out one or more operations at the terminal.

In one or more example methods, determining S112 bottleneck data indicative of a bottleneck of one or more operations associated with the shipment of a container at a terminal comprises determining S112A whether at least one of the one or more predicted performance metrics satisfy one or more criteria. In some examples, the one or more predicted performance metrics may correspond with a given criterion. For example, each predicted performance metric may correspond with a given criterion. In some examples, one or more of the one or more criteria comprise one or more thresholds. In some examples, each criterion comprises one or more thresholds. The one or more criteria can for example be seen as targets for the one or more performance metrics.

In one or more example methods, the one or more criteria are based on one or more thresholds. For example, each criteria may correspond with one or more thresholds. In some examples, whether at least one of the predicted performance metrics satisfy the one or more criteria depends on whether at least one of the predicted performance metrics are greater than (or equal to) or less than at least one of the one or more corresponding thresholds. For example, when at least one of the predicted performance metrics is greater than or equal to a corresponding threshold, one of the one or more criteria can be seen as being satisfied by the predicted performance metrics. For example, when at least

one of the predicted performance metrics is less than a corresponding threshold of the one or more thresholds, at least one of the one or more criteria can be seen as not being satisfied by the predicted performance metric.

For example, the Crane Lifts per Hour (CLPH) is associated with a criterion, e.g., where the threshold is for example 40. For example, when the CLPH is lower than the threshold, e.g., 40, the criterion for the CLPH may be seen as not satisfied. For example, when the CLPH is greater than or equal to the threshold, e.g., 40, the criterion for the CLPH may be seen as not satisfied. In some examples, the target CLPH may be 30 or greater.

The predicted performance parameters are for example indicative of a heatmap, e.g., showing utilization of one or more sections, such as blocks, of the yard. The heatmap is for example indicative of how close to capacity a given area, such as block, of the yard is, e.g., how close the block is having no more capacity, such as being full. The heatmap may for example comprise a valuer indicating how close to capacity an area of the yard is. The heatmap for example corresponds with a criterion, e.g., where the threshold is for example 70%, such as 70% full. For example, when the heatmap indicates that the capacity of an area of the yard is lower than a threshold, e.g., 70%, the criterion associated with the heatmap can be seen as satisfied. For example, when the heatmap indicates capacity is greater than or equal to the threshold, e.g., 70%, the criterion associated with the heatmap can be seen as satisfied, e.g., the block of the yard is overloaded.

In one or more example methods, the method 100 comprises, upon determining that at least one of the predicted performance metrics do not satisfy a criterion of the one or more criteria, providing S114 the bottleneck data to a user device. The user device is for example a device associated with a user. In some examples, the user device is an electronic device associated with the user. For example, the user device may be a computer, smartphone, smartwatch, a laptop, a tablet etc. In some examples, providing S114 bottleneck data to a user device comprises alerting a user to a bottleneck, such as alerting a user to a predicted bottleneck associated with the shipment, e.g. by causing a display of a notification on a user device.

In one or more example methods, the method 100 comprises, upon determining that at least one of the predicted performance metrics satisfy a criterion of the one or more criteria, refraining S113 from providing the bottleneck data to a user device.

In one or more example methods, the method 100 comprises updating S118, based on a user input, the input data, and the terminal data. In some examples, the input data and/or the terminal data may for example be updated to improve the efficiency of one or more operations associated with a shipment of a container at a terminal. In one or more example methods, the method 100 comprises, upon determining that at least one of the predicted performance metrics do not satisfy a criterion of the one or more criteria, updating the input data and/or the terminal data. In some examples, updating S118 the input data and the terminal data may comprise obtaining, such as receiving and/or retrieving, updated input data and/or updated terminal data, e.g. based on input from a user of the electronic device (e.g. to iterate on the simulation). In some examples, updating S118 the input data and the terminal data may comprise obtaining, such as receiving, updated input data and/or terminal data, based on a user input. In some examples, updating S118 the input data and the terminal data may comprise obtaining, such as receiving, updated input data and/or terminal data from one or more data sources (e.g., TOS, equipment database, etc.) that are updated.

In one or more example methods, the method 100 comprises simulating S120, based on the updated input data and the updated terminal data, one or more updated terminal operations. In other words, simulating S120 one or more terminal operations comprises simulating periodically, such as periodically per unit time, e.g., each hour, based on the updated input data and the updated terminal data, one or more updated terminal operations.

In one or more example methods, controlling S124, based on the control data, the operation associated with the shipment comprises one or more of: updating S124A a yard allocation of containers in the terminal and updating S124B operations of terminal equipment at the terminal.

Fig. 4 shows a block diagram of an example electronic device 300 according to the disclosure. The electronic device 300 comprises memory circuitry 301, processor circuitry

302, and an interface 303. The electronic device 300 is configured to perform any of the methods disclosed in Figs. 3A-C. In other words, the electronic device 300 is configured for enabling operations associated with a shipment of a container at a terminal. In some examples, the electronic device 300 is a simulation device. In some examples, the electronic device 300 is a server. In some examples, the electronic device is for example a user device for planning terminal operations. In some examples, the electronic device is for example a part of a Terminal Operation System (TOS). In some examples, the electronic device is a part of a system comprising one or more distributed control systems.

The electronic device 300 is configured to obtain (e.g., via memory circuitry 301 and/or interface 303) input data associated with the shipment of the container and terminal data associated with the terminal.

The electronic device 300 is configured to simulate (e.g., via processor circuitry 302), based on the input data and the terminal data, one or more terminal operations.

The electronic device 300 is configured to determine (e.g., via processor circuitry 302), based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment.

The electronic device 300 is configured to provide (e.g., via processor circuitry 302 and/or interface 303) the one or more performance metrics.

The processor circuitry 302 is optionally configured to perform any of the operations disclosed in Figs. 3A-C (such as any one or more of: S102, S104, S106, S108, S108A, S108B, S108C, S108CA, S110, S110A, S112, S112A, S113, S114, S116, S118, S120, S122, S124, S124A, S124B). The operations of the electronic device 300 may be embodied in the form of executable logic routines (e.g., lines of code, software programs, etc.) that are stored on a non-transitory computer readable medium (e.g., the memory circuitry 301) and are executed by the processor circuitry 302).

Furthermore, the operations of the electronic device 300 may be considered a method that the electronic device 300 is configured to carry out. Also, while the described functions and operations may be implemented in software, such functionality may as well be carried out via dedicated hardware or firmware, or some combination of hardware, firmware and/or software.

The memory circuitry 301 may be one or more of a buffer, a flash memory, a hard drive, a removable media, a volatile memory, a non-volatile memory, a random access memory (RAM), or other suitable device. In a typical arrangement, the memory circuitry 301 may include a non-volatile memory for long term data storage and a volatile memory that functions as system memory for the processor circuitry 302. The memory circuitry 301 may exchange data with the processor circuitry 302 over a data bus. Control lines and an address bus between the memory circuitry 301 and the processor circuitry 302 also may be present (not shown in Fig. 4). The memory circuitry 301 is considered a non-transitory computer readable medium.

The memory circuitry 301 may be configured to store input data, terminal data, one or more terminal operations, one or more performance metrics, historical data, a distribution, a route, a yard allocation, routing technique, constraint data and/or bottleneck data in a part of the memory.

Embodiments of methods and products (electronic device) according to the disclosure are set out in the following items:

Item 1. A method, performed by an electronic device, for enabling operations associated with a shipment of a container at a terminal, the method comprising:

obtaining input data associated with the shipment of the container and terminal data associated with the terminal;

simulating, based on the input data and the terminal data, one or more terminal operations;

determining, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment; and

providing the one or more performance metrics.

Item 2. The method according to item 1, wherein the input data comprise one or more of: vessel data, container data, and voyage data.

Item 3. The method according to any of the previous items, wherein the terminal data comprise one or more of: Berth planning data, terminal equipment availability data, terminal equipment allocation data, yard data, yard allocation data, and yard inventory data.

Item 4. The method according to any of the previous items, wherein the one or more of the determined performance metrics comprise one or more of: terminal equipment performance parameter, a crane intensity parameter, a port movement parameter, a container movement parameter, a crane movement parameter, a crane lift parameter, a rope attachment parameter, and a last line removal parameter.

Item 5. The method according to any of the previous items, the method comprising:

generating, based on the one or more determined performance metrics, control data for controlling an operation associated with the shipment; and

controlling, based on the control data, an operation associated with the shipment.

Item 6. The method according to any of the previous items, wherein the method comprises obtaining historical data indicative one or more of: one or more historical shipments, historical Berth planning, and one or more historical terminal operations.

Item 7. The method according to item 6, wherein simulating, based on the input data and the terminal data, the one or more terminal operations comprises:

- generating, based on the input data, the terminal data, and the historical data, a distribution indicative of historical terminal operations; and
- predicting, based on the distribution, one or more terminal operations.

Item 8. The method according to any of items 6-7, wherein simulating the one or more terminal operations comprises determining a route to a yard allocation for the container, and terminal equipment associated with carrying out the route, by applying a routing technique to one or more of: the input data, the terminal data, and the historical data.

Item 9. The method according to any of items 7-8, wherein determining, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment comprises predicting, based on the one or more simulated terminal operations and/or based on the distribution, one or more performance metrics.

Item 10. The method according to any of the previous items, wherein the method comprises determining, based on the input data and/or the terminal data, constraint data indicative of one or more constraints associated with the shipment and/or the terminal.

Item 11. The method according to any of the previous items, wherein the method comprises determining, based on the one or more predicted performance metrics, bottleneck data indicative of a bottleneck of one or more operations associated with the shipment of a container at a terminal.

Item 12. The method according to item 11, wherein determining bottleneck data indicative of a bottleneck of one or more operations associated with the shipment of a container at a terminal comprises determining whether at least one of the predicted performance metrics satisfy one or more criteria.

Item 13. The method according to item 12, wherein the method comprises, upon determining that at least one of the predicted performance metrics do not satisfy a criterion of the one or more criteria, providing the bottleneck data to a user device.

Item 14. The method according to any of the previous items, wherein the method comprises updating, based on a user input, the input data, and the terminal data.

Item 15. The method according to item 14, wherein the method comprises simulating, based on the updated input data and the updated terminal data, one or more updated terminal operations.

Item 16. The method according any of items 5-15, wherein controlling, based on the control data, the operation associated with the shipment comprises one or more of: updating a yard allocation of containers in the terminal, and updating operations of terminal equipment at the terminal.

Item 17. An electronic device comprising memory circuitry, processor circuitry, and an interface, wherein the electronic device is configured to perform any of the methods according to any of items 1-16.

Item 18. A computer readable storage medium storing one or more programs, the one or more programs comprising instructions, which when executed by an electronic device cause the electronic device to perform any of the methods of items 1-16.

The use of the terms “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. does not imply any particular order, but are included to identify individual elements. Moreover, the use of the terms “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. does not denote any order or importance, but rather the terms “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. are used to distinguish one element from another. Note that the words “first”, “second”, “third” and “fourth”, “primary”, “secondary”, “tertiary” etc. are used here and elsewhere for labelling purposes only and are not intended to denote any specific spatial or temporal ordering. Furthermore, the labelling of a first element does not imply the presence of a second element and vice versa.

It may be appreciated that the Figures comprise some circuitries or operations which are illustrated with a solid line and some circuitries or operations which are illustrated with a dashed line. The circuitries or operations which are comprised in a solid line are circuitries or operations which are comprised in the broadest example embodiment. The circuitries or operations which are comprised in a dashed line are example embodiments which may be comprised in, or a part of, or are further circuitries or operations which may be taken in addition to the circuitries or operations of the solid line example embodiments. It should be appreciated that these operations need not be performed in order presented. Furthermore, it should be appreciated that not all of the operations need to be performed. The exemplary operations may be performed in any order and in any combination.

It is to be noted that the word "comprising" does not necessarily exclude the presence of other elements or steps than those listed.

It is to be noted that the words "a" or "an" preceding an element do not exclude the presence of a plurality of such elements.

It is to be noted that the term "indicative of" may be seen as “associated with”, “related to”, “descriptive of”, “characterizing”, and/or “defining”. The terms “indicative of”, “associated with”, “related to”, “descriptive of”, “characterizing”, and “defining” can be used interchangeably. The term “indicative of” can be seen as indicating a relation. For example, weight data indicative of weight may comprise one or more weight parameters.

It is to be noted that the word "based on" may be seen as “as a function of” and/or “derived from”. The terms “based on” and “as a function of” can be used interchangeably. For example, a parameter determined “based on” a data set can be seen as a parameter determined “as a function of” the data set. In other words, the parameter may be an output of one or more functions with the data set as an input.

A function may be characterizing a relation between an input and an output, such as mathematical relation, a database relation, a hardware relation, logical relation, and/or other suitable relations.

It should further be noted that any reference signs do not limit the scope of the claims, that the exemplary embodiments may be implemented at least in part by means of both hardware and software, and that several "means", "units" or "devices" may be represented by the same item of hardware.

The various exemplary methods, devices, nodes, and systems described herein are described in the general context of method steps or processes, which may be implemented in one aspect by a computer program product, embodied in a computer-readable medium, including computer-executable instructions, such as program code, executed by computers in networked environments. A computer-readable medium may include removable and non-removable storage devices including, but not limited to, Read Only Memory (ROM), Random Access Memory (RAM), compact discs (CDs), digital versatile discs (DVD), etc. Generally, program circuitries may include routines, programs, objects, components, data structures, etc. that perform specified tasks or implement specific abstract data types. Computer-executable instructions, associated data structures, and program circuitries represent examples of program code for executing steps of the methods disclosed herein. The particular sequence of such executable instructions or associated data structures represents examples of corresponding acts for implementing the functions described in such steps or processes.

Although features have been shown and described, it will be understood that they are not intended to limit the claimed disclosure, and it will be made obvious to those skilled in the art that various changes and modifications may be made without departing from the scope of the claimed disclosure. The specification and drawings are, accordingly, to be regarded in an illustrative rather than restrictive sense. The claimed disclosure is intended to cover all alternatives, modifications, and equivalents.

CLAIMS

1. A method, performed by an electronic device, for enabling operations associated with a shipment of a container at a terminal, the method comprising:
obtaining input data associated with the shipment of the container and terminal data associated with the terminal;
simulating, based on the input data and the terminal data, one or more terminal operations;
determining, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment; and
providing the one or more performance metrics.

2. The method according to claim 1, wherein the input data comprise one or more of: vessel data, container data, and voyage data.

3. The method according to any of the previous claims, wherein the terminal data comprise one or more of: Berth planning data, terminal equipment availability data, terminal equipment allocation data, yard data, yard allocation data, and yard inventory data.

4. The method according to any of the previous claims, wherein the one or more of the determined performance metrics comprise one or more of: terminal equipment performance parameter, a crane intensity parameter, a port movement parameter, a container movement parameter, a crane movement parameter, a crane lift parameter, a rope attachment parameter, and a last line removal parameter.

5. The method according to any of the previous claims, the method comprising:
generating, based on the one or more determined performance metrics, control data for controlling an operation associated with the shipment; and
controlling, based on the control data, an operation associated with the shipment.

6. The method according to any of the previous claims, wherein the method comprises obtaining historical data indicative one or more of: one or more historical shipments, historical Berth planning, and one or more historical terminal operations.

7. The method according to claim 6, wherein simulating, based on the input data and the terminal data, the one or more terminal operations comprises:

- generating, based on the input data, the terminal data, and the historical data, a distribution indicative of historical terminal operations; and
- predicting, based on the distribution, one or more terminal operations.

8. The method according to any of claims 6-7, wherein simulating the one or more terminal operations comprises determining a route to a yard allocation for the container, and terminal equipment associated with carrying out the route, by applying a routing technique to one or more of: the input data, the terminal data, and the historical data.

9. The method according to any of claims 7-8, wherein determining, based on the one or more simulated terminal operations, one or more performance metrics associated with the shipment comprises predicting, based on the one or more simulated terminal operations and/or based on the distribution, one or more performance metrics.

10. The method according to any of the previous claims, wherein the method comprises determining, based on the input data and/or the terminal data, constraint data indicative of one or more constraints associated with the shipment and/or the terminal.

11. The method according to any of the previous claims, wherein the method comprises determining, based on the one or more predicted performance metrics, bottleneck data indicative of a bottleneck of one or more operations associated with the shipment of a container at a terminal.

12. The method according to claim 11, wherein determining bottleneck data indicative of a bottleneck of one or more operations associated with the shipment of a container at a terminal comprises determining whether at least one of the predicted performance metrics satisfy one or more criteria.

13. The method according to claim 12, wherein the method comprises, upon determining that at least one of the predicted performance metrics do not satisfy a criterion of the one or more criteria, providing the bottleneck data to a user device.

14. The method according to any of the previous claims, wherein the method comprises updating, based on a user input, the input data, and the terminal data.

15. The method according to claim 14, wherein the method comprises simulating, based on the updated input data and the updated terminal data, one or more updated terminal operations.

16. The method according any of claims 5-15, wherein controlling, based on the control data, the operation associated with the shipment comprises one or more of: updating a yard allocation of containers in the terminal, and updating operations of terminal equipment at the terminal.

17. An electronic device comprising memory circuitry, processor circuitry, and an interface, wherein the electronic device is configured to perform any of the methods according to any of claims 1-16.

18. A computer readable storage medium storing one or more programs, the one or more programs comprising instructions, which when executed by an electronic device cause the electronic device to perform any of the methods of claims 1-16.