

DESCRIPTION

Title of Invention

INFORMATION PROCESSING METHOD, STOWAGE METHOD, PROGRAM, AND INFORMATION PROCESSING DEVICE

Technical Field

[0001]

The present disclosure relates to an information processing method, a stowage method, a program, and an information processing device.

Background Art

[0002]

A method for stowing goods on a tray such as a pallet and shipping the goods is known. For example, PTL 1 discloses an automatic shipping device that transports goods tray on a belt conveyor, stows the goods on the goods tray on the belt conveyor, and ships the stowed goods.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2020-83486

Summary of Invention

Technical Problem

[0004]

Here, it is required to suitably create a stowage plan in accordance with work

details.

[0005]

The present disclosure aims to provide an information processing method, a stowage method, a program, and an information processing device, which can suitably create a stowage plan in accordance with work details.

Solution to Problem

[0006]

According to the present disclosure, there is provided an information processing method including a step of acquiring work information indicating goods to be shipped to a shipping destination;

a step of calculating an initial solution indicating stowage information indicating goods allocated to each of a plurality of pallets and a stacking order of the goods on the pallet, and a stowage order indicating an order of stowing the pallets, based on the work information, a step of calculating an initial evaluation value indicating a degree of load of shipping work in the initial solution, based on the initial solution, a step of calculating a neighborhood solution obtained by changing a part of the stowage information and the stowage order, with respect to the initial solution, based on the initial solution, a step of calculating a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution, and a step of setting the stowage information and the stowage order to be used for a stowage plan, based on the initial evaluation value and the neighborhood evaluation value.

[0007]

According to the present disclosure, there is provided a stowage method including stowing the goods in the plurality of pallets, based on the stowage information

and the stowage order which are set in the information processing method.

[0008]

According to the present disclosure, there is provided a program that causes a computer to execute a process including a step of acquiring work information indicating goods to be shipped to a shipping destination, a step of calculating an initial solution indicating stowage information indicating goods allocated to each of a plurality of pallets and a stacking order of the goods on the pallet, and a stowage order indicating an order of stowing the pallets, based on the work information, a step of calculating an initial evaluation value indicating a degree of load of shipping work in the initial solution, based on the initial solution, a step of calculating a neighborhood solution obtained by changing a part of the stowage information and the stowage order, with respect to the initial solution, based on the initial solution, a step of calculating a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution, and a step of setting the stowage information and the stowage order to be used for a stowage plan, based on the initial evaluation value and the neighborhood evaluation value.

[0009]

According to the present disclosure, there is provided an information processing device including a work information acquisition unit that acquires work information indicating goods to be shipped to a shipping destination, an initial solution calculation unit that calculates an initial solution indicating stowage information indicating goods allocated to each of a plurality of pallets and a stacking order of the goods on the pallet, and a stowage order indicating an order of stowing the pallets, based on the work information, an initial evaluation value calculation unit that calculates an initial evaluation value indicating a degree of load of shipping work in the initial solution,

based on the initial solution, a neighborhood solution calculation unit that calculates a neighborhood solution obtained by changing a part of the stowage information and the stowage order, with respect to the initial solution, based on the initial solution, a neighborhood evaluation value calculation unit that calculates a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution, and a setting unit that sets the stowage information and the stowage order to be used for a stowage plan, based on the initial evaluation value and the neighborhood evaluation value.

Advantageous Effects of Invention

[0010]

According to the present disclosure, it is possible to suitably create a stowage plan in accordance with work details.

Brief Description of Drawings

[0011]

FIG. 1 is a schematic diagram of a stowage system according to the present embodiment.

FIG. 2 is a schematic block diagram of an information processing device according to the present embodiment.

FIG. 3 is a schematic diagram illustrating an example of an initial solution.

FIG. 4 is a schematic diagram illustrating an example of a first neighborhood solution.

FIG. 5 is a schematic diagram illustrating an example of a second neighborhood solution.

FIG. 6 is a schematic diagram illustrating an example of a third neighborhood solution.

FIG. 7 is a flowchart for describing a setting flow of stowage information and a stowage order.

FIG. 8 is a schematic diagram for describing the setting of goods information.

FIG. 9 is a schematic diagram for describing the setting of the goods information.

FIG. 10 is a schematic diagram for describing the setting of the goods information.

FIG. 11 is a schematic diagram for describing the setting of the goods information.

FIG. 12 is a process flow for describing a method for allocating individual goods.

FIG. 13 is a process flow for describing a method for allocating all goods.

FIG. 14 is a schematic diagram for describing setting stacking information.

FIG. 15 is a schematic diagram for describing the setting of the stacking information.

FIG. 16 is a schematic diagram for describing the setting of the stacking information.

FIG. 17 is a schematic diagram for describing the setting of the stacking information.

FIG. 18 is a flowchart for describing a process flow of setting the stowage information.

FIG. 19 is a schematic diagram for describing the setting of the stowage order.

FIG. 20 is a flowchart for describing a process flow of setting the stowage order and a use pallet.

FIG. 21 is a schematic diagram for describing setting an initial solution of a stowage order in a third embodiment.

FIG. 22 is a flowchart for describing a process flow of setting the stowage order

in the third embodiment.

FIG. 23 is a flowchart for describing a process flow of setting a use pallet in the third embodiment.

Description of Embodiments

[0012]

Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. The present disclosure is not limited by the embodiments, and when a plurality of the embodiments are provided, the present disclosure also includes a configuration in which the respective embodiments are combined with each other.

[0013]

(First Embodiment)

(Stowage System)

FIG. 1 is a schematic diagram of a stowage system according to the present embodiment. A stowage system 100 according to the present embodiment is a system that stows goods Q on the pallet P in a facility W, based on a stowage plan. More specifically, the stowage system 100 of the present embodiment changes the combination of the goods Q placed on a supply pallet P0 to the pallet P. For example, the facility W is a facility subject to logistics management, such as a warehouse, but may be any facility for carrying out work for stowing the goods Q on the pallet P. The goods Q are stowed on the pallet P, and are products or the like to be shipped, for example. Here, the pallet P is defined by the Japan Pallet Association, as “those including a structure having a surface for placing a cargo bundled into one unit, in which all of cargo loading, transportation, and storage can be performed by human power or a dedicated vehicle such as a forklift, including a superstructure”. In the present

embodiment, the pallet P refers to a container or a platform on which the goods Q are stowed. That is, the pallet referred to here is not limited to a so-called flat plate-shaped platform. The pallet may include a basket wheel or the like, and may have any shape. As on the pallet P, the supply pallet P0 may also be a container or a platform (so-called pallet) on which the goods Q are stowed. In the present embodiment, whereas one type of the goods Q are placed on one supply pallet P0, a plurality of types of the goods Q may be placed on the pallet P in accordance with work details (shipping order). In the present embodiment, the plurality of goods Q are stowed on the pallet P to overlap each other in a layer shape. That is, for example, layers in which the plurality of goods Q are aligned are stacked on the pallet P. A type and a disposition order of the goods Q in one layer of the pallet P and a stacking order of the pallet P are determined by a stowage plan.

[0014]

As illustrated in FIG. 1, the stowage system 100 includes an information processing device 10, a moving body 12, and a stowage device 14. The information processing device 10 creates the stowage plan for stowing the goods Q on the pallet P, and details thereof will be described later. The moving body 12 transports the supply pallet P0 or the pallet P. For example, the moving body 12 may be a forklift, and more specifically, may be a so-called automated guided vehicle (AGV) or an automated guided forklift (AGF). The stowage device 14 is a device (robot) that stows the goods Q on the pallet P, and is a so-called palletizer. A plurality of the moving bodies 12 and a plurality of the stowage devices 14 may be deployed in the facility W.

[0015]

(Facility)

The facility W is provided with a goods storage region AR1 in which the goods

Q are disposed, a supply pallet disposition region AR2 in which the supply pallet P0 is disposed, a pallet disposition region AR3 in which the pallet P is disposed, a shipping item disposition region AR4 in which the pallet P on which the stowage is completed is disposed, and an empty pallet disposition region AR5 in which the empty supply pallet P0 is disposed. The goods Q scheduled to be stowed on the pallet P are stored in the goods storage region AR1. In an example in FIG. 1, the goods Q in a state of being placed on the supply pallet P0 are placed in the goods storage region AR1. However, the present disclosure is not limited thereto, and the goods Q in a state of not being placed on the supply pallet P0 may be stored. In this case, for example, the stowage device 14 may be provided in the goods storage region AR1, and the work for placing the goods Q in the supply pallet P0 may be carried out. In the supply pallet disposition region AR2, the supply pallet P0 on which the goods Q are placed is disposed, and on the pallet disposition region AR3, the pallet P on which the goods Q are stowed is disposed. The stowage device 14 picks up the goods Q from the supply pallet P0 disposed in the supply pallet disposition region AR2, and stows the picked-up goods Q on the pallet P disposed on the pallet disposition region AR3. In the shipping item disposition region AR4, the pallet P on which the stowage work is completed on the pallet disposition region AR3 is disposed, and the pallet P may be shipped from this region. In the empty pallet disposition region AR5, an empty pallet (supply pallet P0) on which the goods Q are not stowed is disposed. That is, for example, the empty supply pallet P0 in which the combination of the goods Q is completely changed is disposed in the empty pallet disposition region AR5. The supply pallet P0 or the pallet P may be transported between the respective regions by the moving body 12. A layout of the facility W described above is an example, and is not limited to the above-described configuration.

[0016]

(Information Processing Device)

FIG. 2 is a schematic block diagram of the information processing device according to the present embodiment. The information processing device 10 generates the stowage plan for stowing the goods Q on the pallet P. The information processing device 10 is provided inside the facility W in the example in FIG. 1, but may be provided at any place without being limited thereto. The information processing device 10 is a computer, and as illustrated in FIG. 2, the information processing device 10 includes a communication unit 20, a storage unit 22, and a control unit 24. The information processing device 10 may also include an input unit that receives an input from a user, and an output unit (for example, a display unit that displays an image) that outputs information. The information processing device 10 may be configured as a single device, may be configured to be integrally with another device, or may be configured as a system in which various devices such as a calculation circuit and a data server are combined. The configuration is not particularly limited.

[0017]

The communication unit 20 is a communication module that communicates with an external device, and is an antenna, for example. The information processing device 10 communicates with the external device via wireless communication, but may communicate with the external device via wired communication, and any communication method may be adopted. The storage unit 22 is a memory that stores various types of information, such as calculation contents of the control unit 24 and programs, and for example, the storage unit 22 includes at least one of a main storage device such as a random access memory (RAM) and a read only memory (ROM), and an external storage device such as a hard disk drive (HDD). The program for the

control unit 24 which is stored in the storage unit 22 may be stored in a recording medium readable by the information processing device 10.

[0018]

The control unit 24 is a processing device that performs calculation, and includes a calculation circuit such as a central processing unit (CPU), for example. The control unit 24 includes a work information acquisition unit 30, an initial solution calculation unit 32, a neighborhood solution calculation unit 34, an initial evaluation value calculation unit 36, a neighborhood evaluation value calculation unit 38, a setting unit 40, and an output control unit 42. The control unit 24 realizes the work information acquisition unit 30, the initial solution calculation unit 32, the neighborhood solution calculation unit 34, the initial evaluation value calculation unit 36, the neighborhood evaluation value calculation unit 38, the setting unit 40, and the output control unit 42 by reading and executing a program (software) from the storage unit 22, and performs processes thereof. The control unit 24 may perform the process with one CPU, or may include a plurality of CPUs to perform the process with the plurality of CPUs. In addition, at least some of the processes of the work information acquisition unit 30, the initial solution calculation unit 32, the neighborhood solution calculation unit 34, the initial evaluation value calculation unit 36, the neighborhood evaluation value calculation unit 38, the setting unit 40, and the output control unit 42 may be realized by a hardware circuit.

[0019]

The work information acquisition unit 30 acquires work information indicating work details for generating the stowage plan. The work information includes information indicating the goods Q to be shipped to a shipping destination. The initial solution calculation unit 32 calculates an initial solution indicating stowage information

and a stowage order, based on the work information. The neighborhood solution calculation unit 34 calculates a neighborhood solution, based on the initial solution. The neighborhood solution refers to a solution obtained by changing a part of the stowage information and the stowage order, with respect to the initial solution. The initial evaluation value calculation unit 36 calculates an initial evaluation value indicating a degree of load of the shipping work in the initial solution, based on the initial solution. The neighborhood evaluation value calculation unit 38 calculates a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution. The setting unit 40 sets the stowage information and the stowage order to be used for the stowage plan, based on the initial evaluation value and the neighborhood evaluation value. The output control unit 42 outputs information of the stowage plan including the stowage information and the stowage order to an external device via the communication unit 20. For example, the output control unit 42 transmits the information of the stowage plan to the moving body 12 or the stowage device 14 to cause the moving body 12 or the stowage device 14 to carry out the work, based on the stowage plan.

[0020]

(Process of Information Processing Device)

Hereinafter, specific process contents of the information processing device 10 will be described.

[0021]

(Acquisition of Work Information)

The work information acquisition unit 30 acquires work information indicating work details for generating the stowage plan. The work information acquisition unit 30 may acquire the work information by using any method, but for example, the work

information may be acquired from a device (higher-level system) that manages the facility W via the communication unit 20. The work information is used for setting the stowage information. The work information may be any information that can be used for setting the stowage information, but preferably includes at least information indicating the goods Q to be shipped (goods information). More specifically, in the present embodiment, the work information includes shipping destination information, goods information indicating the goods Q to be shipped to the shipping destination, and supply pallet information indicating the supply pallet P0 on which the goods Q to be shipped is placed. The shipping destination information indicates the shipping destination in the current work. The goods information indicates a type and the number of the goods Q scheduled to be shipped for each shipping destination. In addition to the type and the number of the goods Q, the goods information may include at least one (preferably all) of information indicating a size (for example, lengths in a longitudinal direction, a lateral direction, and a height direction) of the goods Q to be shipped, information indicating an area (for example, lengths in the longitudinal direction and the lateral direction) of one layer of the pallet P, information indicating a weight of the goods Q, and information of a maximum disposition number indicating an upper limit number of the goods Q which can be disposed in one layer on the pallet P. The supply pallet information includes information on a type and the number of the goods Q to be placed on the supply pallet P0.

[0022]

(Calculation of Initial Solution)

The initial solution calculation unit 32 calculates an initial solution indicating stowage information and a stowage order, based on the work information. The stowage information indicates the goods Q (type of the goods Q) allocated to the pallet P and the

stacking order of the goods Q on the pallet P. In other words, the stowage information includes goods information indicating the type and the number of the goods Q allocated to the pallet P, and stowage information indicating how the goods Q indicated by the pallet information are stacked on the pallet P. In addition, the stowage order is information indicating an order of stowing the pallets P, in other words, an order of completing the pallets P for shipping.

[0023]

The initial solution calculation unit 32 sets the stowage information (goods information and stacking information) in the initial solution for each of the plurality of pallets P used for shipping, based on the work information. The initial solution calculation unit 32 may set the stowage information in the initial solution by using any method based on the work information. For example, the initial solution calculation unit 32 may calculate the number of the pallets P to be used for the shipping destination and the type and the number of the goods Q to be allocated to the respective pallets P to be used for the shipping destination, based on the type and the number of the goods Q at each shipping destination indicated by the work information, and may use a calculation result as the goods information in the initial solution. The initial solution calculation unit 32 may calculate the stacking order (stacking information) of the allocated goods Q for the respective pallets P used for the shipping destination, and the calculated stowage order may be used as the stacking information in the initial solution.

[0024]

FIG. 3 is a schematic diagram illustrating an example of the initial solution. In an example in FIG. 3, the stowage information in the initial solution is set such that goods Qa, Qb, and Qc are stacked in this order in a pallet Pa, goods Qd, Qe, and Qf are stacked in this order in a pallet Pb, and goods Qg, Qh, and Qi are stacked in this order

in a pallet Pc.

[0025]

The initial solution calculation unit 32 sets the stowage order (order of completing the pallets P) in the initial solution, based on the work information. The initial solution calculation unit 32 may set the stowage order in the initial solution by using any method based on the work information. For example, the initial solution calculation unit 32 may set the stowage order in the initial solution, based on the stowage information in the initial solution, which is calculated, based on the work information. That is, the initial solution calculation unit 32 may calculate the stowage order in the initial solution, based on the type and the number of the goods Q allocated to the respective pallets P (goods information in the initial solution) and the stacking order of the goods Q in the respective pallets P (stacking information in the initial solution).

[0026]

In the example in FIG. 3, the stowage order in the initial solution is set to carry out the stowage work in the order of the pallet Pa, the pallet Pb, and the pallet Pc.

[0027]

In the initial solution calculation unit 32, it is preferable that the initial solution also includes the pallet information indicating the supply pallet P0 serving as a supply source of the goods Q allocated to the pallet P. The pallet information is set for each of the goods Q allocated to the pallet P in the initial solution. That is, in the example in FIG. 3, the supply pallet P0 serving as the supply source of the goods is set for each of the goods Qa to Qi. The initial solution calculation unit 32 may set the pallet information by using any method based on the work information. For example, the initial solution calculation unit 32 may set the pallet information by specifying the supply pallet P0 on which the goods Q allocated to the pallet P are placed in the initial

solution, based on the work information.

[0028]

(Calculation of Neighborhood Solution)

The neighborhood solution calculation unit 34 calculates the neighborhood solution indicating the stowage information and the stowage order, based on the initial solution. The neighborhood solution is the same as the initial solution in that the neighborhood solution is a solution including the stowage information and the stowage order, but is different from the initial solution in that the stowage information and the stacking order are partially different. That is, as the neighborhood solution, the neighborhood solution calculation unit 34 calculates a solution obtained by partially changing the type and the number of the goods Q to be placed on the pallet P, the stacking order of the goods Q on the pallet P, and the order of completing the pallet P from the initial solution. The neighborhood solution calculation unit 34 may calculate a plurality of types of the neighborhood solutions. That is, the neighborhood solution calculation unit 34 may calculate the plurality of types of the neighborhood solutions such that the stowage information and the stowage order are partially different from those of the initial solution and a part of the stowage information and the stowage order are different even between the neighborhood solutions.

[0029]

The neighborhood solution calculation unit 34 may calculate the neighborhood solution by using any method based on the initial solution. However, in the present embodiment, the neighborhood solution calculation unit 34 calculates any of a first neighborhood solution to a fourth neighborhood solution, which will be described below, as the neighborhood solution.

[0030]

(First Neighborhood Solution)

FIG. 4 is a schematic diagram illustrating an example of the first neighborhood solution. As a neighborhood solution, the neighborhood solution calculation unit 34 may calculate the first neighborhood solution which is a solution obtained by exchanging the goods Q allocated to the plurality of pallets P having the same shipping destination with each other, with respect to the initial solution. That is, with respect to the stacking information in the initial solution, the neighborhood solution calculation unit 34 sets new stowage information (first stowage information) by exchanging the goods Q allocated to the pallet P and the goods Q allocated to another pallet P having the same shipping destination as the pallet P. The neighborhood solution calculation unit 34 calculates the stowage information in the initial solution as the first neighborhood solution by using a solution changed to the first stowage information. The first neighborhood solution has the same details as the initial solution, except that the stowage information is changed to the first stowage information. That is, the neighborhood solution calculation unit 34 calculates the first neighborhood solution not to be changed from the initial solution, except that the goods Q of the plurality of pallets P having the same shipping destination are exchanged with each other. In some cases, the neighborhood solution may be calculated multiple times. In this case, as will be described in detail later, a solution having a higher evaluation value in the initial solution and the neighborhood solution is set as an optimal solution, and a new neighborhood solution is calculated, based on the optimal solution. Therefore, as the first neighborhood solution, the neighborhood solution calculation unit 34 calculates a solution obtained by exchanging the goods Q allocated to the plurality of pallets P having the same shipping destination with each other, with respect to the optimal solution (initial solution having a higher evaluation value than the calculated

neighborhood solution or calculated neighborhood solution having a higher evaluation value than the initial solution).

[0031]

The neighborhood solution calculation unit 34 may exchange the goods Q among the three or more pallets P having the same shipping destination with each other, with respect to the initial solution (optimal solution), but it is preferable that a solution obtained by exchanging the goods Q allocated to the two pallets P having the same shipping destination with each other, with respect to the initial solution is calculated as the first neighborhood solution. In addition, the neighborhood solution calculation unit 34 may exchange the plurality of types of the goods Q with each other, with respect to the initial solution (optimal solution), but it is preferable that a solution obtained by exchanging one type of the goods Q with each other is calculated as the first neighborhood solution. That is, it is preferable that the neighborhood solution calculation unit 34 calculates the first neighborhood solution by exchanging one types of the goods Q allocated to the two pallets P having the same shipping destination with each other, by means of so-called swap nearby. In addition, it is preferable that the goods Q to be exchanged have different types, but the goods Q having the same type and different numbers may be exchanged with each other.

[0032]

In FIG. 4, as an example of the first neighborhood solution, an example is illustrated in which the goods Q allocated to the pallet Pa and the pallet Pb which have the same shipping destination are exchanged with each other. That is, in the example in FIG. 3, in the initial solution, the goods Qa, Qb, and Qc are allocated to the pallet Pa in this order, and the goods Qd, Qe, and Qf are allocated to the pallet Pb in this order. In contrast, in the first neighborhood solution illustrated in FIG. 4, the goods Qb

allocated to the pallet Pa and the goods Qe allocated to the pallet Pb are exchanged with each other. That is, in the first neighborhood solution, the goods Qa, Qe, and Qc are allocated to the pallet Pa in this order, and the goods Qd, Qb, and Qf are allocated to the pallet Pb in this order. That is, a position of the exchanged goods Q on the pallet P in the first neighborhood solution (stacking position of the goods Qe in FIG. 4) is the same as a position of the goods Q before the exchange on the pallet P in the initial solution (stacking position of the goods Qb in FIG. 3).

[0033]

(Second Neighborhood Solution)

FIG. 5 is a schematic diagram illustrating an example of a second neighborhood solution. As the neighborhood solution, the neighborhood solution calculation unit 34 may calculate the second neighborhood solution obtained by changing the stacking order of the goods Q on the pallet P, with respect to the initial solution. That is, with respect to the stacking information in the initial solution, the neighborhood solution calculation unit 34 changes the stacking order of the goods Q allocated to the pallet P, with respect to the stowage information in the initial solution, and sets new stowage information (second stowage information). As the second neighborhood solution, the neighborhood solution calculation unit 34 calculates a solution obtained by changing the stowage information in the initial solution to the second stowage information. The second neighborhood solution has the same details as the initial solution, except that the stowage information is changed to the second stowage information. That is, the neighborhood solution calculation unit 34 calculates the second neighborhood solution not to be changed from the initial solution, except that the stacking orders of the goods Q on the pallet P are exchanged. As described above, in some cases, the neighborhood solution may be calculated multiple times. Therefore, as the second neighborhood

solution, the neighborhood solution calculation unit 34 can calculate a solution obtained by changing the stacking order of the goods Q on the pallet P, with respect to the optimal solution (initial solution having a higher evaluation value than the calculated neighborhood solution or the calculated neighborhood solution having a higher evaluation value than the initial solution).

[0034]

The neighborhood solution calculation unit 34 may exchange the stowage orders of three or more goods Q allocated to the same pallet P, with respect to the initial solution (optimal solution), but as the second neighborhood solution, it is preferable to calculate a solution obtained by exchanging the stacking orders of two goods Q allocated to the same pallet P with each other, with respect to the initial solution. In addition, the neighborhood solution calculation unit 34 may exchange the stacking orders of the goods Q in the plurality of pallets P, with respect to the initial solution (optimal solution), but as the second neighborhood solution, it is preferable to calculate a solution obtained by exchanging the stacking orders of the goods Q allocated to one pallet P with each other. That is, it is preferable that the neighborhood solution calculation unit 34 calculates the second neighborhood solution by exchanging the stacking orders of the two goods Q in one pallet P by means of the so-called swap nearby.

[0035]

In FIG. 5, as an example of the second neighborhood solution, an example is illustrated in which the stacking orders of the goods Q allocated to the pallet Pa are exchanged. That is, in the example in FIG. 3, in the initial solution, the goods Qa, Qb, and Qc are allocated to the pallet Pa in this order. In contrast, in the second neighborhood solution illustrated in FIG. 5, the stacking orders of the goods Qb and Qc are exchanged with each other, and the goods Qa, Qc, and Qb are allocated to the pallet

Pa in this order.

[0036]

(Third Neighborhood Solution)

FIG. 6 is a schematic diagram illustrating an example of a third neighborhood solution. As the neighborhood solution, the neighborhood solution calculation unit 34 may calculate the third neighborhood solution obtained by changing the order (stowage order) of stowing the pallets P, with respect to the initial solution. That is, as the third neighborhood solution, the neighborhood solution calculation unit 34 calculates a solution obtained by changing the stowage order in the initial solution. The third neighborhood solution has the same details as the initial solution except that the stowage order is changed. That is, the neighborhood solution calculation unit 34 calculates the third neighborhood solution not to be changed from the initial solution, except that the stowage orders are exchanged with each other. As described above, in some cases, the neighborhood solutions may be calculated multiple times. Therefore, as the third neighborhood solution, the neighborhood solution calculation unit 34 can calculate a solution obtained by changing the order (stowage order) of stowing the pallet P, with respect to the optimal solution (initial solution having a higher evaluation value than the calculated neighborhood solution, or calculated neighborhood solution having a higher evaluation value than the initial solution).

[0037]

The neighborhood solution calculation unit 34 may exchange the stowage orders (completing orders) of three or more pallets P, with respect to the initial solution (optimal solution), but as the third neighborhood solution, it is preferable to calculate a solution obtained by exchanging the stowage orders of two pallets P with each other, with respect to the initial solution. That is, it is preferable that the neighborhood

solution calculation unit 34 calculates the third neighborhood solution by exchanging the stowage orders of the two pallets P with each other by means of the so-called swap nearby.

[0038]

In FIG. 6, as an example of the third neighborhood solution, an example is illustrated in which the stowage orders of the pallet Pa and the pallet Pb are exchanged. That is, in the example in FIG. 3, the stowage is performed in the order of the pallets Pa, Pb, and Pc in the initial solution, but in the third neighborhood solution illustrated in FIG. 6, the stowage is performed in the order of the pallets Pb, Pa, and Pc.

[0039]

(Fourth Neighborhood Solution)

As the neighborhood solution, the neighborhood solution calculation unit 34 may calculate a solution obtained by changing the supply pallet P0 for supplying the goods Q allocated to the pallet P, with respect to the initial solution. That is, as the fourth neighborhood solution, the neighborhood solution calculation unit 34 calculates a solution obtained by changing the pallet information (information indicating the supply pallet P0 serving as the supply source of the goods Q) in the initial solution. The fourth neighborhood solution has the same details as the initial solution, except that the pallet information is changed. That is, the neighborhood solution calculation unit 34 calculates the fourth neighborhood solution not to be changed from the initial solution, except that the supply pallet P0 is changed. As described above, in some cases, the neighborhood solution may be calculated multiple times. Therefore, as the fourth neighborhood solution, the neighborhood solution calculation unit 34 can calculate a solution obtained by changing the supply pallet P0, with respect to the optimal solution (initial solution having a higher evaluation value than the calculated neighborhood

solution or calculated neighborhood solution having a higher evaluation value than the initial solution).

[0040]

The neighborhood solution calculation unit 34 may change the supply pallet P0 for the plurality of types of the goods Q in the initial solution (optimal solution), but as the fourth neighborhood solution, it is preferable to calculate a solution obtained by changing only the supply pallet P0 for one type of goods Q in the initial solution. In addition, as the fourth neighborhood solution, it is preferable that the neighborhood solution calculation unit 34 calculates a solution obtained by exchanging the supply pallet P0 set in the initial solution (optimal solution) to another supply pallet P0 on which the same number of the same goods Q as the supply pallet P0 are placed. That is, it is preferable that the neighborhood solution calculation unit 34 calculates the fourth neighborhood solution by exchanging two supply pallets P0 on which the same number of the same goods Q are placed with each other by means of the so-called swap nearby.

[0041]

In the example in FIG. 3, in the initial solution, the goods Qa is allocated to the pallet Pa. In this case, for example, as the fourth neighborhood solution, a solution obtained by changing the supply pallet P0 of the goods Qa allocated to the pallet Pa with respect to the initial solution may be calculated.

[0042]

(Combination of Respective Neighborhood Solutions)

When the plurality of types of neighborhood solutions are calculated, the neighborhood solution calculation unit 34 may calculate the plurality of types of neighborhood solutions using at least one of the first neighborhood solution to the fourth neighborhood solution. That is, the neighborhood solution calculation unit 34 may

calculate a plurality of types of neighborhood solutions using only any one of the first neighborhood solution to the fourth neighborhood solution, may calculate a plurality of types of neighborhood solutions using a plurality of the first neighborhood solution to the fourth neighborhood solution, and may calculate a plurality of types of neighborhood solutions using all of the first neighborhood solution to the fourth neighborhood solution.

[0043]

More specifically, a priority may be set for each of the first neighborhood solution to the fourth neighborhood solution. In this case, the neighborhood solution calculation unit 34 calculates a plurality of neighborhood solutions by using a calculation method for a neighborhood solution having the highest priority among the first neighborhood solution to the fourth neighborhood solution. Then, if the neighborhood solutions of all combinations using the calculation method having the highest priority are calculated before the lapse of the predetermined time (that is, while the calculation time so far is equal to or smaller than the threshold value), the calculation of the neighborhood solutions may be continued using the calculation method having the next highest priority. That is, for example, when a priority of the first neighborhood solution is highest, the neighborhood solution calculation unit 34 calculates a plurality of first neighborhood solutions by changing the pallet P or the goods Q to be exchanged. When the calculation of the first neighborhood solution for all combinations is completed before a predetermined time elapses (that is, while a calculation time so far is equal to or smaller than a threshold value), the same calculation is continued by using a calculation method for the neighborhood solution having a next higher priority.

[0044]

(Calculation of Initial Evaluation Value)

The initial evaluation value calculation unit 36 calculates an initial evaluation

value indicating a degree of load of the shipping work in the initial solution, based on the initial solution. The initial evaluation value is an index for evaluating the initial solution. As will be described in detail later, the information processing device 10 also calculates a neighborhood evaluation value for evaluating the neighborhood solution, and uses a solution having a higher evaluation value in the initial evaluation value and the neighborhood evaluation value for the stowage plan.

[0045]

The initial evaluation value is an index indicating a degree of a work load when it is assumed that the work for shipping the pallet P is carried out by stowing the goods Q on the pallet P in the stowage information and the stowage order which are indicated by the initial solution. The initial evaluation value calculation unit 36 may calculate the initial evaluation value by using any method based on the initial solution. However, in the present embodiment, the initial evaluation value is calculated, based on at least any one of a work load of the stowage device 14 that stows the goods Q on the pallet P, a work load of the moving body 12 that transports the pallet P, and a small lot consecutive number.

[0046]

(Work Load of Stowage Device)

When the initial evaluation value is calculated, based on the work load of the stowage device 14, the initial evaluation value calculation unit 36 calculates the work load of the stowage device 14, based on the initial solution. The work load of the stowage device 14 here is a degree of load of the work carried out by the stowage device 14 when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution. For example, the initial evaluation value calculation unit 36 may calculate a total number of

times of stowing the goods Q on the pallet P (pallet for shipping) from the supply pallet P0 when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution, and may use the total number of times as the initial evaluation value.

[0047]

(Work Load of Moving Body)

When the initial evaluation value is calculated, based on the work load of the moving body 12, the initial evaluation value calculation unit 36 calculates the work load of the moving body 12, based on the initial solution. The work load of the moving body 12 here is a degree of load of the work carried out by the moving body 12 when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution. For example, the initial evaluation value calculation unit 36 may calculate the total number of times at which the moving body 12 transports the pallet P when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution, and may use the total number of times as the initial evaluation value.

[0048]

In the facility W, in some cases, both the AGV and the AGF may be deployed as the moving body 12. The AGV does not have a function as a forklift, and is the moving body that does not have a fork capable of lifting the pallet P. The AGF is the moving body having a function as the forklift. For example, the AGV carries out work for transporting the pallet P among the goods storage region AR1, the supply pallet disposition region AR2, the pallet disposition region AR3, the shipping item disposition region AR4, and the empty pallet disposition region AR5. For example, the AGF

carries out work for transporting the pallet P (pallet for shipping) disposed in the region AR4 to a shelf. However, the work carried out by the AGV and the AGF is not limited thereto, and may be set as appropriate. When both the AGV and the AGF are deployed in this way, the initial evaluation value calculation unit 36 may calculate at least one of the work load of the AGV and the work load of the AGF, as the work load of the moving body 12. For example, the work load of the AGV includes the total number of times at which the AGV transports the pallet P when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution. For example, the work load of the AGF includes the total number of times at which the AGF transports the pallet P when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution.

[0049]

(Small Lot Consecutive Number)

The small lot consecutive number refers to the number of times of continuously stowing the goods Q (goods Q of a small lot), the number of the goods Q allocated to the pallet P being equal to or smaller than a predetermined number. That is, when the predetermined number is set to two, the predetermined number refers to the number of times of continuously stowing the goods Q of which the number allocated to the pallet P is two or smaller. When the number of the goods Q allocated to the pallet P is small, the work time for the stowage device 14 to stow the goods Q decreases. On the other hand, when the number of types of the goods Q allocated to the pallet P is large, the number of times of transporting the supply pallet P0 to the supply pallet disposition region AR2 increases. Therefore, when the number of small lot consecutive items increases, whereas the work time for each of the goods Q of the stowage device 14

decreases, the number of times of transporting the supply pallet P0 increases. Therefore, when the stowage device 14 is in a state where the subsequent work can be started, there is a high possibility that the supply pallet P0 is not supplied in time. In this way, when the small lot consecutive number increases, the stowage device 14 waits for the arrival of the supply pallet P0 or the number of times of transporting the moving body 12 increases. Therefore, the small lot consecutive number can be an index corresponding to a degree of load of the shipping work.

[0050]

When the initial evaluation value is calculated, based on the small lot consecutive number, the initial evaluation value calculation unit 36 calculates the small lot consecutive number, based on the initial solution. For example, the initial evaluation value calculation unit 36 may calculate the small lot consecutive number when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the initial solution, and may use the small lot consecutive number as the initial evaluation value.

[0051]

(Combination of Respective Initial Evaluation Values)

The initial evaluation value calculation unit 36 may calculate the initial evaluation value, based on at least any one of the work load of the stowage device 14, the work load of the moving body 12, and the small lot consecutive number. That is, the initial evaluation value calculation unit 36 may calculate the initial evaluation value by using only any one of the work load of the stowage device 14, the work load of the moving body 12, and the small lot consecutive number, may calculate the initial evaluation value by using a plurality of the above-described factors, or may calculate the initial evaluation value by using all of the above-described factors.

[0052]

More specifically, a priority may be set for each of the work load of the stowage device 14, the work load of the moving body 12, and the small lot consecutive number. In this case, the initial evaluation value calculation unit 36 may calculate the initial evaluation value by using one having the highest priority among these factors. In this case, as will be described in detail later, the information processing device 10 may compare the calculated initial evaluation value with the neighborhood evaluation value (to be described later), and when the evaluations are the same, the information processing device 10 may calculate the initial evaluation value by using the subsequently highest priority, and may repeat the same process.

[0053]

(Calculation of Neighborhood Evaluation Value)

The neighborhood evaluation value calculation unit 38 calculates a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution. When a plurality of the neighborhood solutions are calculated, the neighborhood evaluation value calculation unit 38 calculates the neighborhood evaluation value for each of the neighborhood solutions.

[0054]

The neighborhood evaluation value is an index indicating a degree of the work load when it is assumed that the work for shipping the pallet P is carried out by stowing the goods Q on the pallet P in the stowage information and the stowage order which are indicated by the neighborhood solution. The neighborhood evaluation value calculation unit 38 calculates the neighborhood evaluation value by using the same method as the calculation method for the initial evaluation value, except that the initial

solution is replaced with the neighborhood solution. That is, in the present embodiment, the neighborhood evaluation value calculation unit 38 calculates the neighborhood evaluation value, based on at least any one of the work load of the stowage device 14 that stows the goods Q on the pallet P, the work load of the moving body 12 that transports the pallet P, and the small lot consecutive number.

[0055]

(Work Load of Stowage Device)

When the neighborhood evaluation value is calculated, based on the work load of the stowage device 14, the neighborhood evaluation value calculation unit 38 calculates the work load of the stowage device 14, based on the neighborhood solution. For example, the neighborhood evaluation value calculation unit 38 may calculate the total number of times of stowing the goods Q on the pallet P (a pallet for shipping) from the supply pallet P0 when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the neighborhood solution, and may use the total number of times as the neighborhood evaluation value.

[0056]

(Work Load of Moving Body)

When the neighborhood evaluation value is calculated, based on the work load of the moving body 12, the neighborhood evaluation value calculation unit 38 calculates the work load of the moving body 12, based on the neighborhood solution. For example, the neighborhood evaluation value calculation unit 38 may calculate the total number of times at which the moving body 12 transports the pallet P when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the neighborhood solution, and may use the total number of times as the neighborhood evaluation value.

[0057]

When both the AGV and the AGF are deployed, the neighborhood evaluation value calculation unit 38 may calculate at least one of the work load of the AGV and the work load of the AGF, as the work load of the moving body 12. For example, the work load of the AGV includes the total number of times at which the AGV transports the pallet P when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the neighborhood solution. For example, the work load of the AGF includes the total number of times at which the AGF transports the pallet P when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the neighborhood solution.

[0058]

(Small Lot Consecutive Number)

When the neighborhood evaluation value is calculated, based on the small lot consecutive number, the neighborhood evaluation value calculation unit 38 calculates the small lot consecutive number, based on the neighborhood solution. For example, the neighborhood evaluation value calculation unit 38 may calculate the small lot consecutive number when it is assumed that the goods Q are stowed on the pallet P in the stowage information and the stowage order which are indicated by the neighborhood solution, and may use the small lot consecutive number as the neighborhood evaluation value.

[0059]

(Combination of Respective Neighborhood Evaluation Values)

The neighborhood evaluation value calculation unit 38 may calculate the neighborhood evaluation value, based on at least any one of the work load of the stowage

device 14, the work load of the moving body 12, and the small lot consecutive number.

[0060]

More specifically, a priority may be set for each of the work load of the stowage device 14, the work load of the moving body 12, and the small lot consecutive number. In this case, the neighborhood evaluation value calculation unit 38 may calculate the neighborhood evaluation value by using the one having the highest priority among these factors. In this case, as will be described in detail later, the information processing device 10 may compare the initial evaluation value and the neighborhood evaluation value having the highest priority, and when the evaluations are the same, the information processing device 10 may calculate the neighborhood evaluation value by using the subsequently highest priority, and may repeat the same process.

[0061]

(Setting of Stowage Information and Stowage Order)

The setting unit 40 sets the stowage information and the stowage order to be used for the stowage plan, based on the initial evaluation value and the neighborhood evaluation value. Specifically, the setting unit 40 sets the stowage information and the stowage order which are included in a solution in which the evaluation has a high evaluation value in the initial solution and the neighborhood solution, as the stowage information and the stowage order to be used for the stowage plan. That is, for example, when the evaluation of the initial evaluation value is higher than the neighborhood evaluation value, the setting unit 40 sets the stowage information and the stowage order which are included in the initial solution, as the stowage information and the stowage order to be used for the stowage plan. On the other hand, when the evaluation of the neighborhood evaluation value is higher than the initial evaluation value, the setting unit 40 sets the stowage information and the stowage order which are included in the

neighborhood solution, as the stowage information and the stowage order to be used for the stowage plan. In the example of the present embodiment, the initial evaluation value and the neighborhood evaluation value are set such that the evaluation becomes higher as the evaluation value is lower. However, the present invention is not limited thereto, and the initial evaluation value and the neighborhood evaluation value may be set such that the evaluation becomes higher as the evaluation value is lower.

[0062]

In addition, when the plurality of neighborhood solutions are calculated, the setting unit 40 performs the same process for each of the neighborhood solutions. That is, for example, the setting unit 40 sets the solution having a higher evaluation in the initial solution and the neighborhood solution, as the optimal solution. The setting unit 40 compares the evaluation value of the optimal solution with the evaluation value of another neighborhood solution, and sets the solution with the higher evaluation as the optimal solution. That is, the setting unit 40 compares the optimal solution at the current time with the evaluation value of the non-evaluated neighborhood solution, and sets the solution having the higher evaluation value, as the optimal solution. When the evaluation comparison of all of the neighborhood solutions are completed, the stowage information and the stowage order which are included in the optimal solution at that time are set as the stowage information and the stowage order to be used for the stowage plan.

[0063]

(Process Flow)

A setting flow of the stowage information and the stowage order to be used for the stowage plan described above will be described. FIG. 7 is a flowchart illustrating the setting flow of the stowage information and the stowage order. As illustrated in

FIG. 7, the information processing device 10 causes the work information acquisition unit 30 to acquire the work information (Step S2). The information processing device 10 causes the initial solution calculation unit 32 to calculate the initial solution of the stowage information and the stowage order, based on the work information (Step S4), and causes the initial evaluation value calculation unit 36 to calculate the initial evaluation value corresponding to the initial solution (Step S6). In addition, the information processing device 10 causes the neighborhood solution calculation unit 34 to calculate the neighborhood solution of the stowage information and the stowage order, based on the initial solution (Step S8), and causes the neighborhood evaluation value calculation unit 38 to calculate the neighborhood evaluation value corresponding to the neighborhood solution (Step S10).

[0064]

The information processing device 10 causes the setting unit 40 to compare the evaluation values with each other (here, the initial evaluation value and the neighborhood evaluation value), and when the evaluation value corresponding to a new solution has the higher evaluation (Step S12; Yes), the information processing device 10 causes the setting unit 40 to set the new solution, as the optimal solution (Step S14). That is, for example, when the neighborhood evaluation value has the higher evaluation than the initial evaluation value, the neighborhood solution corresponding to the neighborhood evaluation value is set as the optimal solution. When the calculation time so far is equal to or smaller than a threshold value (Step S16; Yes), and when it is possible to create another neighborhood solution that is not calculated so far (Step S18; Yes), the process returns to Step S8, another neighborhood solution that is not calculated so far is calculated, and a process subsequent thereto is repeated. That is, in this case, when the neighborhood evaluation value corresponding to the newly calculated

neighborhood solution has the higher evaluation by comparing the neighborhood evaluation value corresponding to the newly calculated neighborhood solution with the evaluation value corresponding to the optimal solution, the newly calculated neighborhood solution is updated as the optimal solution. On the other hand, when the neighborhood evaluation value corresponding to the newly calculated neighborhood solution has the lower evaluation, the optimal solution is not updated.

[0065]

In addition, when the evaluation value corresponding to the original solution has the higher evaluation than the evaluation value of the new solution (Step S12; No), the original solution is set to the optimal solution (Step S15). That is, for example, in the first calculation, when the initial evaluation value has the higher evaluation than the neighborhood evaluation value, the initial evaluation value is set to the optimal solution. In addition, for example, when the evaluation value corresponding to the set optimal solution has the higher evaluation than the newly calculated neighborhood evaluation value when the calculation is repeated, the optimal solution is used as it is as the optimal solution.

[0066]

When the calculation time so far is greater than the threshold value (Step S16; No), this process ends. In this case, the stowage information and the stowage order in the optimal solution at that time are set as the stowage information and the stowage order to be used for the stowage plan.

[0067]

Similarly, when it is impossible to create another neighborhood solution (Step S18; No), this process ends. In this case, the stowage information and the stowage order in the optimal solution at that time are set as the stowage information and the

stowage order to be used for the stowage plan.

[0068]

Whether another neighborhood solution can be created, which is illustrated in Step S18, may be determined by using any method. For example, it is determined that the neighborhood solution having partially different details (stowage information or stowage order) can be calculated with respect to the neighborhood solution calculated so far by using a calculation method for the currently used neighborhood solution (for example, a calculation method for the first neighborhood solution). When the neighborhood solution can be calculated in this way, it is determined that another neighborhood solution can be created, and another neighborhood solution is calculated by using the calculation method for the currently used neighborhood solution.

[0069]

On the other hand, when the neighborhood solution having partially different details (stowage information or stowage order) cannot be calculated by using the calculation method for the currently used neighborhood solution, it is determined whether there is a calculation method (for example, a calculation method for the second neighborhood solution) that is different from the currently used calculation method and that is not used so far. When this calculation method is present, it is determined that another neighborhood solution can be created, and the calculation method is switched to the calculation method (for example, the calculation method for the second neighborhood solution), and the neighborhood solution is continuously calculated by using the calculation method. On the other hand, when there is no calculation method that is not used so far (when all of the calculation methods are used), it is determined that another neighborhood solution cannot be created. When a plurality of the calculation methods are used for this way, a priority may be set for the calculation

methods, and the calculation methods may be applied in order of the higher priority.

[0070]

In addition, when the evaluation value is calculated, a priority of using any of the work load of the stowage device 14, the work load of the moving body 12, and the small lot consecutive number may be set. In this case, the information processing device 10 calculates the evaluation value (initial evaluation value or neighborhood evaluation value) by using the one having the highest priority among these factors. As illustrated in Steps S12 to S16, when the evaluations of the calculated evaluation values are different from each other, the solution having the higher evaluation value is set as the optimal solution. On the other hand, when the evaluation of the calculated evaluation values are the same, the information processing device 10 re-calculates the evaluation value (initial evaluation value or neighborhood evaluation value) by using the one having the next higher priority, and repeats the same process.

[0071]

The priority in calculating the evaluation value may be set as appropriate. For example, the priority may be lowered in the order of the work load of the stowage device 14, the work load of the moving body 12, and the small lot consecutive number, or the priority may be lowered in the order of the work load of the stowage device 14, the small lot consecutive number, and the work load of the moving body 12. In addition, the priority may be lowered in the order of the work load of the moving body 12, the work load of the stowage device 14, and the small lot consecutive number, or the priority may be lowered in the order of the work load of the moving body 12, the small lot consecutive number, and the work load of the stowage device 14. In addition, the priority may be lowered in the order of the small lot consecutive number, the work load of the stowage device 14, and the work load of the moving body 12, or the priority may be lowered in

the order of the small lot consecutive number, the work load of the moving body 12, and the work load of the stowage device 14. In addition, as described above, the work load of the moving body 12 may be divided into the work load of the AGV and the work load of the AGF, and the priority may also be set to the work load of the AGV and the work load of the AGF.

[0072]

(Carrying Out Stowage Work)

The information processing device 10 calculates the initial solution and the neighborhood solution as described above, and sets the stowage information and the stowage order to be used for the stowage plan, based on the evaluation values (initial evaluation value and neighborhood evaluation value). The stowage plan may also include information of the supply pallet P0 for supplying the goods Q to the pallet P. The output control unit 42 of the information processing device 10 outputs the generated stowage plan (information including the stowage information and the stowage order) to an external device. For example, in the present embodiment, the output control unit 42 outputs the stowage plan to another device of the stowage system 100, and another device carries out the stowage work (stowing the goods Q on the pallet P) in accordance with the stowage plan. That is, for example, the output control unit 42 transmits the stowage plan to a control unit (not illustrated) that controls an operation of the stowage device 14, and the control unit controls the operation of the stowage device 14 to carry out the stowage work in accordance with the stowage plan. For example, the output control unit 42 transmits the stowage plan to a control unit (not illustrated) that controls an operation of the moving body 12, and the control unit controls the operation of the moving body 12 to carry out the stowage work in accordance with the stowage plan.

[0073]

(Advantageous Effects)

As described above, the information processing device 10 according to the present embodiment calculates the initial solution and the neighborhood solution, and sets the stowage information and the stowage order to be used for the stowage plan, based on the evaluation values (initial evaluation value and neighborhood evaluation value). Therefore, according to the present embodiment, it is possible to suitably create the stowage plan in accordance with the work details. That is, since the neighborhood solution obtained by partially changing the initial solution is created and evaluated, it is possible to set the stowage plan optimized in accordance with the work details. Furthermore, since the neighborhood solution obtained by only partially changing the initial solution without changing all of the initial solutions, the stowage plan optimized in accordance with the work details can be set while an excessive increase in the calculation load can be suppressed.

[0074]

[Others]

In the description of the present embodiment, the neighborhood solution is always calculated to create the stowage plan. However, the present invention is not limited thereto, and it is possible to determine whether to use the neighborhood solution. That is, for example, the information processing device 10 determines whether to calculate the neighborhood solution, and when it is determined to calculate the neighborhood solution, the information processing device 10 creates the stowage plan by using the method described in the above-described embodiment. On the other hand, when it is determined not to calculate the neighborhood solution, the information processing device 10 does not calculate the neighborhood solution and the neighborhood evaluation value, and sets the stowage information and the stowage order in the initial

solution, as a solution to be used for the stowage plan. Any method for determining whether to calculate the neighborhood solution may be adopted. For example, information on whether to calculate the neighborhood solution may be input to the information processing device 10 by a user, and the information processing device 10 may determine whether to calculate the neighborhood solution from an input result thereof. In addition, for example, the information processing device 10 may automatically determine whether to calculate the neighborhood solution. In this case, for example, the information processing device 10 may determine whether to use the neighborhood solution, based on the work information.

[0075]

(Second Embodiment)

Next, a second embodiment will be described. The second embodiment is different from the first embodiment in that a specific calculation method of the initial solution is specified. In the second embodiment, elements common to those of the first embodiment will be omitted in the description.

[0076]

In the second embodiment, as the stowage information in the initial solution, the initial solution calculation unit 32 calculates the goods information indicating the type and the number of the goods Q allocated to the pallet P and the stacking information indicating how the goods Q indicated by the pallet information are stacked on the pallet P.

[0077]

(Setting of Goods Information)

(Calculation of Number of Individual Goods)

FIGS. 8 to 11 are schematic diagrams for describing the setting of the goods

information. When the goods information is set in the initial solution, the initial solution calculation unit 32 classifies the goods Q to be shipped to a target shipping destination into entire goods and individual goods, and calculates the number of the goods Q classified into the individual goods (number of individual goods). The entire goods refer to the goods Q stacked on the pallet to occupy all of respective layers when it is assumed that the goods Q are stacked on the pallet P occupy all of one layer, and the individual goods refer to the goods Q remained without occupying all of one layer in that case. That is, the entire goods are the goods Q stowed over an entire region of a region where the pallet P can be stowed in one layer, and the individual goods are the goods Q stowed only in a part of the region where the pallet P can be stowed in one layer. The initial solution calculation unit 32 classifies the goods Q into the entire goods and the individual goods, based on information on the number of the goods Q to be shipped to the target shipping destination and information on the maximum disposition number of the goods Q, which are indicated by the work information, and calculates the number of the individual goods for the goods Q. In the present embodiment, as the number of the individual goods, the initial solution calculation unit 32 calculates the number of the remaining goods Q when the number of the individual goods Q to be shipped to the shipping destination is divided by the maximum disposition number. That is, when 18 goods Q are shipped and the maximum disposition number is 4 as an example, in a case where the goods Q are stowed on the pallet P such that the goods Q occupy all of one layer, 2 goods Q remain after 4 layers are stacked. Therefore, in this example, the entire goods are 16 pieces in four layers, and the individual goods are two pieces. When there are no remaining goods Q when the number of the goods Q is divided by the maximum disposition number (when divided), all are classified into the entire goods. Therefore, the number of the individual goods is zero.

[0078]

The initial solution calculation unit 32 classifies the goods Q into the entire goods and the individual goods for each type of the goods Q to be shipped to the shipping destination, and calculates the number of the individual goods for each goods Q. FIG. 8 illustrates an example in which 18 of the goods QA, 2 of the goods QB, 12 of the goods QC, and 6 of the goods QD are scheduled to be shipped to a certain shipping destination, and illustrates a case where the maximum disposition number of the goods QA is 4, the maximum disposition number of the goods QB is 2, and the maximum disposition number of the goods QC and QD is 3. In this case, in an example in FIG. 8, the goods QA is classified into 16 of the entire goods QA1 and 2 of the individual goods QA2, and the goods QB, QC, and QD do not include the individual goods. All are classified into the entire goods QB1, QC1, and QD1.

[0079]

(Allocation of Individual Goods)

Next, the initial solution calculation unit 32 allocates the individual goods (goods Q of the number classified into the individual goods) to the pallet P. Allocating the goods Q to the pallet P refers to selecting the goods Q scheduled to be stowed on the pallet P (selecting the pallet P scheduled to stow the goods Q). The initial solution calculation unit 32 searches for whether each individual goods of one type of the goods Q can be disposed in one layer of the pallet P. The initial solution calculation unit 32 searches for whether there is a disposition of the individual goods in which the individual goods do not overlap each other in one layer, based on a size of the goods Q and an area of one layer of the pallet P which are indicated in the work information. Any search method may be adopted here, but for example, the Bottom-Left method may be used. The initial solution calculation unit 32 allocates the individual goods of the

goods Q to the pallet P, when the individual goods do not overlap with each other in one layer. On the other hand, the initial solution calculation unit 32 does not allocate the individual goods of the goods Q to the pallet P, when there is no disposition in which the individual goods do not overlap with each other in one layer. For example, in FIG. 9, an example is illustrated in which the two individual goods QA2 are allocated to the pallet PA since it is determined that the two individual goods QA2 (all of the individual goods QA2) can be disposed in one layer on the pallet PA. When it is determined that the individual goods are not allocated to the pallet P, the initial solution calculation unit may search for whether the individual goods can be allocated to another pallet P, or may determine whether the total number of the individual goods can be divided into a plurality of groups, the individual goods can be allocated to the pallet P for each group.

[0080]

In this way, in the present embodiment, when the individual goods of one type of the goods Q can be disposed in one layer, the individual goods are allocated to the pallet PA. However, a determination criterion for the allocation is not limited thereto. For example, when there is a disposition in which the individual goods do not overlap each other in one layer and a total height obtained by adding the height of the individual goods and the height of the entire goods obtained by laying up all of the entire goods of the same type as the individual goods (height of the entire goods) is equal to or lower than a predetermined threshold height, the individual goods may be allocated to the pallet PA. That is, even when there is a disposition in which the individual goods do not overlap each other in one layer, when the total height obtained by laying up the entire goods of the same type as the individual goods is higher than the threshold height, the individual goods do not need to be allocated to the pallet PA. The entire goods height may be calculated by using any method, but for example, may be a value obtained by

multiplying the number of laying up the entire goods calculated by dividing the total number of the entire goods by the maximum disposition number by the height of the entire goods, and the same applies hereinafter. That is, for example, in the example in FIG. 8, since four layers are obtained when all of the entire goods QAs 1 of the goods QA are stacked, a value obtained by adding the entire goods height of the four layers of the entire goods QAs 1 and the height of the individual goods QA 2 is the total height. When the total height is higher than the threshold height, the individual goods QA 2 do not need to be allocated to the pallet PA.

[0081]

When the individual goods are present in a plurality of types of the goods Q for one shipping destination, the initial solution calculation unit 32 allocates the individual goods to the pallet P for each type of the goods Q by using the same method. An order of allocating the individual goods for each type of the goods Q may be adopted, but it is preferable to allocate the individual goods of the goods Q having the low height in the plurality of types of the goods Q.

[0082]

In addition, when the individual goods are present in the plurality of types of the goods Q, the initial solution calculation unit 32 may allocate the plurality of types of the individual goods to one layer of one pallet P. Specifically, the initial solution calculation unit 32 searches for whether there is the disposition of individual goods that do not overlap the allocated individual goods and the currently allocated individual goods do not overlap each other, in one layer. The initial solution calculation unit 32 allocates the individual goods to the pallet P, when there is the disposition of the individual goods that do not overlap the allocated individual goods and the currently allocated individual goods do not overlap each other. On the other hand, when the

individual goods are not disposed in this way, the initial solution calculation unit 32 does not allocate the individual goods to the pallet P, and allocates the individual goods to another pallet P, for example. That is, for example, when two individual goods of other types can be disposed without overlapping the same layer as two individual goods QA2, with respect to the pallet PA to which two individual goods QA2 are allocated, the two individual goods are also allocated to the same layer as the individual goods QA2 of the pallet PA. On the other hand, when the individual goods cannot be disposed without overlapping the same layer as the individual goods QA2, the individual goods are allocated to another pallet P.

[0083]

The initial solution calculation unit 32 performs the process of allocating the individual goods to the pallet P for each individual goods.

[0084]

(Allocation of Entire Goods to Pallet to Which Individual Goods Are Allocated)

The initial solution calculation unit 32 allocates the entire goods (goods Q of the number classified into the entire goods) to the pallet P to which the individual goods are allocated. The initial solution calculation unit 32 preferentially allocates the entire goods of the same type as the allocated individual goods to the pallet P. Specifically, the initial solution calculation unit 32 selects the entire goods of the same type as the individual goods from the entire goods for the target shipping destination, and determines whether the selected entire goods can be allocated to the pallet P to which the individual goods are allocated. The initial solution calculation unit 32 calculates the entire goods height of the selected entire goods (height at which all of the entire goods are stacked) and the total height of the allocated individual goods. When the total height is equal to or lower than the threshold height, the initial solution calculation

unit 32 determines that all of the selected entire goods can be allocated to the pallet PA, and allocates that all of the selected entire goods to the pallet PA. On the other hand, when the total height is higher than the threshold height, the initial solution calculation unit 32 does not allocate the selected entire goods to the pallet PA, and allocates the selected entire goods to another pallet P. In the example in FIG. 10, since the total height obtained by adding the entire goods height of the four layers including the total number of the entire goods QA1 and the height of the individual goods QA2 is equal to or smaller than the threshold height, all of the entire goods QA1 are allocated to the pallet PA. In this way, the type of the goods Q stowed on the pallet PA is prevented from increasing by prioritizing the allocation of the entire goods of the same type as the individual goods, and the number of times of replacement of the supply pallet P0 for stowage can be reduced, so that the work time can be reduced.

[0085]

The initial solution calculation unit 32 may also allocate an entire goods of another type to the pallet P to which the individual goods and the entire goods have been allocated. In this case, the initial solution calculation unit 32 selects the entire goods of which the type is not determined to be allocated, from the entire goods for the target shipping destination, and determines whether the selected entire goods can be allocated to the pallet P in which the individual goods and the entire goods are allocated. The initial solution calculation unit 32 calculates a total height of the entire goods height of the selected entire goods (height of all of the stacked entire goods), the entire goods height of the allocated entire goods, and the height of the allocated individual goods. The initial solution calculation unit 32 determines that all of the selected entire goods can be allocated to the pallet P and performs the allocation when the total height is equal to or smaller than the threshold height. On the other hand, when the total height is

higher than the threshold height, the initial solution calculation unit 32 does not allocate the selected entire goods to the pallet P, and allocates the selected entire goods to another pallet P. In an example in FIG. 10, the total height obtained by adding the height of one layer including the total number of the entire goods QB1, the height of four layers of the entire goods QA1, and the height of the individual goods QA2 is equal to or lower than the threshold height. Therefore, all of the entire goods QB1 are allocated to the pallet PA.

[0086]

Even when the entire goods of the same type as the individual goods are not allocated to the pallet P to which the individual goods are allocated, the entire goods of another type may be allocated to the pallet P. In this case, the initial solution calculation unit 32 selects the entire goods of the type in which the allocation is not determined from the entire goods for the target shipping destination, calculates the total height of the entire goods height of the selected entire goods (height at which all of the entire goods are stacked) and the height of the allocated individual goods, and allocates all of the selected entire goods to the pallet PA, when the total height is equal to or lower than the threshold height. On the other hand, when the total height is higher than the threshold height, the initial solution calculation unit 32 does not allocate the selected entire goods to the pallet P, and allocates the selected entire goods to another pallet P.

[0087]

The initial solution calculation unit 32 sequentially selects the entire goods of the type in which the allocation is not determined, and repeats the above-described process for the pallet P to which the individual goods are allocated. In this manner, the initial solution calculation unit 32 allocates the entire goods to the pallet P to which the individual goods are allocated.

[0088]

The initial solution calculation unit 32 performs the above-described process of allocating the entire goods for the respective pallets P to which the individual goods are allocated.

[0089]

(Allocation of Entire Goods to Pallet to Which Individual Goods Are Not Allocated)

When the process of allocating the entire goods for the pallet P to which the individual goods are allocated is completed, the initial solution calculation unit 32 allocates the entire goods (goods Q of the number classified into the entire goods) in which the allocation is not determined, to the pallet P to which the individual goods are not allocated. The initial solution calculation unit 32 selects the entire goods of the type in which the allocation is not determined, from the entire goods for the target shipping destination, and determines whether the selected entire goods can be allocated to the pallet P to which the individual goods are not allocated. The initial solution calculation unit 32 calculates the entire goods height of the selected entire goods (height at which all of the entire goods are stacked). When the entire goods height is equal to or lower than the threshold height, the initial solution calculation unit 32 determines that all of the selected entire goods can be allocated to the pallet P, and allocates all of the selected entire goods to the pallet P. On the other hand, when the entire goods height is higher than the threshold height, the initial solution calculation unit 32 does not allocate the selected entire goods to the pallet P. In this way, since the same type of the entire goods are preferentially allocated, an increase in the number of types of the goods Q stowed on the pallet PA is suppressed, the number of times of replacing the supply pallet P0 for stowage is suppressed, and a work time can be reduced.

[0090]

The initial solution calculation unit 32 may allocate another type of the entire goods to the pallet P to which the individual goods are not allocated but to which the entire goods are allocated. In this case, the initial solution calculation unit 32 selects the entire goods of the type in which the allocation is not determined, from the entire goods for the target shipping destination, and determines whether the selected entire goods can be allocated to the pallet P to which the entire goods are allocated. The initial solution calculation unit 32 calculates the total height of the entire goods height of the selected entire goods and the entire goods height of the allocated entire goods. When the total height is equal to or lower than the threshold height, the initial solution calculation unit 32 determines that all of the selected entire goods can be allocated to the pallet P, and allocates all of the selected entire goods to the pallet P. On the other hand, when the total height is higher than the threshold height, the initial solution calculation unit 32 does not allocate the selected entire goods to the pallet P, and allocates the selected entire goods to another pallet P. In an example in FIG. 11, the total height of the height of four layers including the total number of the entire goods QC1 and the height of two layers including the total number of the entire goods QD1 is equal to or lower than the threshold height. Therefore, all of the entire goods QC1 and QD1 are allocated to the pallet PB.

[0091]

The initial solution calculation unit 32 sequentially selects the entire goods of the type in which the allocation is not determined, and repeats the above-described process for the pallet P to which the individual goods are allocated. In this manner, the initial solution calculation unit 32 allocates the entire goods to the pallet P to which the individual goods are not allocated. That is, when new entire goods cannot be allocated

to one pallet P, the new pallet P is selected, and the entire goods are allocated to the newly selected pallet P by using the same method. In the above description, the total number of one type of the entire goods is allocated to one pallet P. However, when the total number of the entire goods cannot be allocated to any pallet P, the total number of the entire goods may be divided into each layer, and may be allocated to the pallet P for each layer.

[0092]

The initial solution calculation unit 32 allocates the individual goods to the pallet P, and allocates the entire goods to the pallet P such that all of the goods Q of the shipping destination are allocated to any pallet P for each shipping destination by the using the above-described method. In this manner, the goods information indicating the type and the number of the goods Q allocated to the respective pallets P is set for each shipping destination.

[0093]

In addition, in the above description, the entire goods are sequentially selected and allocated to the pallet P to which the individual goods are allocated and the pallet P to which the individual goods are not allocated. In that case, any order of selecting the entire goods may be adopted. For example, the initial solution calculation unit 32 may alternately select the entire goods of the type having the maximum entire goods height (height at which all of the entire goods are stacked) and the entire goods of a type having the minimum entire goods height, from the entire goods of a type which is not selected yet. That is, for example, the initial solution calculation unit 32 selects the entire goods having the maximum entire goods height from the entire goods which are not selected, thereafter, selects the entire goods having the minimum entire goods height from the remaining (not selected) entire goods, and thereafter, selects the entire goods having the

maximum entire goods height from the remaining entire goods. Since the initial solution calculation unit 32 alternately selects the entire goods having the maximum and minimum entire goods heights in this way, the entire goods can be stacked on the pallet P as high as possible, and the number of pallets P to be used can be reduced. In addition, for example, the initial solution calculation unit 32 may alternately select the entire goods of the type having the maximum number and the entire goods of the type having the minimum number, from the entire goods of the type which is not selected yet. That is, for example, the initial solution calculation unit 32 selects the entire goods having the maximum number from the entire goods which are not selected, thereafter, selects the entire goods having the minimum number from the remaining (not selected) entire goods, and thereafter, selects the entire goods having the maximum number from the remaining entire goods. Since the initial solution calculation unit 32 alternately selects the entire goods having the maximum and minimum number in this way, the entire goods can be stacked on the pallet P as many as possible, and the number of pallets P to be used can be reduced.

[0094]

Furthermore, when a method for alternately selecting the entire goods having the maximum entire goods height and the entire goods having the minimum entire goods height is defined as a first selection method and a method for alternately selecting the entire goods having the maximum number and the entire goods having the minimum number is defined as a second selection method, the initial solution calculation unit 32 may determine which of the first selection method and the second selection method is to be used, based on the number of pallets P required when all of the goods Q are allocated or one shipping destination. In this case, for example, the initial solution calculation unit 32 sets the goods information (allocates the individual goods and the

entire goods) such that all of the goods Q of the shipping destination are allocated to any of the pallets P by using the above-described method while the unselected entire goods are selected by using the first selection method. In addition, the initial solution calculation unit 32 sets the goods information (allocates the individual goods and the entire goods) such that all of the goods Q of the shipping destination are allocated to any of the pallets P by using the above-described method while the unselected entire goods are selected by using the second selection method. The initial solution calculation unit 32 may compare the total number of pallets P required when all of the goods Q are allocated by using the first selection method with the total number of pallets P required when all of the goods Q are allocated by using the second selection method, and may treat the goods information set by the selection method having the smaller total number of pallets P, as the goods information used for the stowage plan.

[0095]

(Flow of Setting Goods Information)

A process flow of setting the goods information in the initial solution described above will be described. FIG. 12 is a process flow for describing a method for allocating the individual goods, and FIG. 13 is a process flow for describing a method for allocating the entire goods. As illustrated in FIG. 12, when the individual goods are allocated to the pallet P, the initial solution calculation unit 32 selects the individual goods (Step S22), determines whether the total number of the selected individual goods can be disposed in one layer of the selected pallet P (Step S24), allocates the total number of the individual goods to the pallet P (Step S26) when the total number of the individual goods can be disposed in one layer (Step S24; Yes), and ends this process when other individual goods are present (Step S28; No). On the other hand, when other individual goods are present (Step S28; Yes), the process returns to Step S22, and the process of

selecting other individual goods and allocating the selected individual goods to the pallet P is continued. Even when the selected individual goods cannot be disposed in one layer of the pallet P (Step S24; No), the process proceeds to Step S28. When the selected individual goods cannot be disposed in one layer of the selected pallet P, another pallet P may be selected, and it may be determined whether the individual goods can be disposed in one layer of another pallet P.

[0096]

As illustrated in FIG. 13, when the entire goods are allocated to the pallet P, the initial solution calculation unit 32 selects the pallet P and the entire goods (Step S30), determines whether the total number of selected entire goods can be allocated to the selected pallet P (Step S32), allocates the total number of the entire goods to the pallet P (Step S34) when the total number of the entire goods can be allocated to the pallet P (Step S32; Yes), and ends this process when other entire goods are not present (Step S36; No). On the other hand, when other entire goods are present (Step S36; Yes), the process returns to Step S30, and the process of selecting other entire goods and allocating the selected entire goods to the pallet P is continued. In addition, even when the selected entire goods cannot be allocated to the selected pallet P (Step S32; No), the process proceeds to Step S36. After determining whether all of the entire goods can be allocated to the selected pallet P, when the entire goods in which the allocation is not determined still remain, the process returns to Step S30, another pallet P is selected, and it is determined whether the entire goods in which the allocation is not determined can be allocated to another pallet P.

[0097]

(Setting of Stacking Information)

Since the goods information set in the above description indicates the type and

the number of the goods Q (individual goods and entire goods) allocated to the pallet P, it is not determined yet how the allocated goods Q are disposed on the pallet P. Therefore, in the present embodiment, when the initial solution is set, the initial solution calculation unit 32 sets the stacking goods information in the initial solution, which indicates how the goods Q are stacked on the pallet P. Hereinafter, the configuration will be specifically described.

[0098]

FIGS. 14 to 17 are schematic diagrams for describing the setting of the stacking information. The initial solution calculation unit 32 sets the same type of the goods Q allocated to one pallet P as one layer group L, and sets the order of overlapping the layer groups L, as the stacking information. The layer group L here can be a collection of layers including the same type of the goods Q, and in some cases of one layer group L, the same type of the goods Q may be disposed in one layer, or may be disposed in a plurality of layers. For example, the number of layers included in the layer group L is a value obtained by dividing the total number of the goods Q by the maximum disposition number, and when the individual goods are included, the number of layers is obtained by adding a value obtained by dividing the total number of the goods Q by the maximum disposition number and the number of layers of the individual goods. That is, for example, the layer group L of the goods QA illustrated in FIG. 10 includes a total of five layers including four layers of the entire goods and one layer of the individual goods.

[0099]

The initial solution calculation unit 32 determines whether the individual goods are allocated to the pallet P, based on the goods information of the pallet P. When the individual goods are allocated, the initial solution calculation unit 32 sets the layer group

L of the goods Q including the individual goods, as an uppermost layer group which is the layer group disposed on an uppermost side of the pallet P. On the other hand, the uppermost layer group is not set at this stage for the pallet P to which the individual goods are not allocated. In this way, since the layer group L including the individual goods is disposed in the uppermost layer, the goods Q can be suitably stacked. In the layer group L of the goods Q including the individual goods, the layer of the individual goods is set as the uppermost layer in the respective layers of the goods Q.

[0100]

In addition, the initial solution calculation unit 32 determines whether there is a maximum weight layer group in which a weight of the goods Q in one layer included in the layer group L is maximum in the layer group L included on the pallet P, based on the goods information of the pallet P. When there is the maximum weight layer group, the initial solution calculation unit 32 sets the maximum weight layer group, as a lowermost layer group which is a layer group disposed on a lowest side of the pallet P. In this case, for example, the initial solution calculation unit 32 can determine whether there is the maximum weight layer group by calculating and comparing the weight of the goods Q in one layer in each layer group L from the weight of the goods Q and the maximum disposition number. When the maximum weight layer group is not present, that is, for example, when there are a plurality of the layer groups L in which the weight of the goods Q in one layer is maximum, the lowermost layer group does not need to be set. In this way, since the heaviest layer is disposed in the lowermost layer, the goods Q can be stowed by keeping weight balance.

[0101]

In an example in FIG. 14, the goods QA including the individual goods QA2 and the goods QB which do not include the individual goods are allocated to the pallet

PA. Therefore, in the example in FIG. 14, the layer group L2 of the goods QA is set as the uppermost layer group of the pallet PA, and the layer group L1 of the remaining goods QB is set as the layer group below the layer group L2 (in the present example, the lowermost layer group). In addition, in the example in FIG. 15, the goods QC and QD which do not include the individual goods are allocated to the pallet PB, and the layer group of the goods QC is the maximum weight layer group. Therefore, in the example in FIG. 15, the layer group L1 of the goods QC is set as the lowermost layer group of the pallet PB, and the layer group L2 of the remaining goods QD is set as the layer group above the layer group L1 (in the present example, the uppermost layer group).

[0102]

Next, the initial solution calculation unit 32 extracts popular goods (target goods) from the goods Q allocated to the pallet P of each shipping destination. The popular goods here refers to the goods Q in which the number of allocated shipping destinations is maximum. That is, for example, when the goods QD are shipped to three shipping destinations and the goods QA, QB, and QD are shipped to two shipping destinations, the goods QD become popular goods. However, the popular goods are not limited to the goods Q having the maximum number of the allocated shipping destinations, may indicate the goods Q of a type selected by using any method from the goods Q allocated to the pallets P of the respective shipping destinations, and may indicate the goods Q having the maximum total number for the respective shipping destinations, for example.

[0103]

When the popular goods are extracted, the initial solution calculation unit 32 selects a first pallet in which the number of allocated popular goods is maxim, on the pallets P of the respective shipping destinations. The initial solution calculation unit 32 sets the layer group L including the popular goods allocated to the selected first pallet,

as the lowermost layer group of the selected first pallet. When there are a plurality of the pallets P in which the number of the allocated popular goods is maximum, any one of the plurality of pallets P may be selected as the first pallet. In addition, when the lowermost layer group of the selected first pallet is already set, the pallet having the maximum number of the popular goods is selected as a new first pallet from the unselected pallets P excluding the first pallet, and the same process is performed. For example, in an example in FIG. 16, in the respective pallets PC, the number of the goods QD which are the popular goods is the maximum. Therefore, the layer group L1 of the goods QD is set as the lowermost layer group.

[0104]

In addition, the initial solution calculation unit 32 selects a second pallet in which the number of allocated popular goods is minimum, on the pallets P of the respective shipping destinations. The initial solution calculation unit 32 sets the layer group L including the popular goods allocated to the selected second pallet as a second layer group, which is the second layer from the lowest side of the selected second pallet. The second layer group can be a layer group directly above the lowermost layer group. When there are a plurality of the pallets P in which the number of the allocated popular goods is the minimum, any one of the pallets P may be selected as the second pallet. In addition, when the second layer group of the selected second pallet is already set, the pallet having the minimum number of the popular goods is selected as a new second pallet from the unselected pallets P excluding the second pallet, and the same process is performed. For example, in an example in FIG. 17, the number of the goods QD which are the popular goods is the minimum in the respective pallets PD. Therefore, the layer group L2 of the goods QD is set as the second layer group. In the example in FIG. 17, the layer group L1 of the goods QA is the heaviest layer group. Therefore, the layer

group L1 of the goods QA is set as the lowermost layer group.

[0105]

When setting the lowest layer group of the first pallet and the second layer group of the second pallet, the initial solution calculation unit 32 selects the first pallet and the second pallet from the unselected pallets P which are not selected as the first pallet and the second pallet so far, and repeats a process of setting the lowest layer group of the first pallet and a process of setting the second layer group of the second pallet. In addition, when all of the pallets P are completely selected for the extracted popular goods, as new popular goods, the initial solution calculation unit 32 extracts the goods Q having the maximum number of allocated shipping destinations from the goods Q excluding the popular goods extracted so far, and repeats a process of selecting the first pallet and setting the lowermost layer group thereof, and a process of selecting the second pallet and setting the second layer group thereof. In this way, the lowest layer group of the first pallet and the second layer group of the second pallet are set as the same popular goods. In this manner, the popular goods can be continuously stowed by the second pallet and the first pallet. Therefore, a time required for stowage can be reduced, and a load of the stowage work can be reduced.

[0106]

Next, the initial solution calculation unit 32 extracts the pallet P in which the stacking order of all of the layer groups L is not determined (pallet P in which the stacking order of at least the partial layer groups L is not determined). The initial solution calculation unit 32 selects the maximum layer group in which the number of the goods Q is maximum from the layer group L in which the stacking order is not determined, for the extracted pallet P, and sets the selected maximum layer group as the lowermost layer group in the layer groups L in which the stowage order is not

determined. That is, for example, when the lowermost layer group is determined and the second layer group (layer group immediately above the lowermost side) is not determined, the maximum layer group is set as the second layer group. When the lowermost layer group and the second layer group are determined, the maximum layer group is set as the layer group immediately above the second layer group. When there are a plurality of layer groups L in which the number of the goods Q are maximum, any one of the layer groups L may be selected as the maximum layer group.

[0107]

Next, the initial solution calculation unit 32 selects the minimum layer group in which the number of the goods Q is minimum, from the layer group L in which the stacking order is not determined, for the extracted pallet P, and sets the selected minimum layer group as the lowermost layer group in the layer groups L in which the stowage order is not determined. Next, the initial solution calculation unit 32 newly selects the maximum layer group in which the number of the goods Q is maximum, from the layer group L in which the stacking order is not determined, for the extracted pallet P, and sets the selected maximum layer group as the lowermost layer group in the layer groups L in which the stowage order is not determined. That is, the initial solution calculation unit 32 sets the stacking order such that the maximum layer group and the minimum layer group are alternately stacked from the bottom, for the layer group L in which the stacking order is not determined. For example, in the example in FIG. 16, on the pallet PC, the maximum layer group of the layer groups L in which the stacking order is not determined is the layer group L2 including the goods QB, and the minimum layer group is the layer group L3 including the goods QC. Therefore, the stacking order is set in the order of the layer group L1, the layer group L2, and the layer group L3. In addition, for example, in the example in FIG. 17, on the pallet PD, the maximum

layer group of the layer groups L in which the stacking order is not determined is the layer group L3 including the goods QC, and the minimum layer group is the layer group L4 including the goods QB. Therefore, the stacking order is set in the order of the layer group L1, the layer group L2, the layer group L3, and the layer group L4. In this way, the maximum layer group and the minimum layer group are alternately stacked in one pallet P. In this manner, a time for replacing the supply pallet P0 stowed in one pallet P can be averaged, a time required for stowage can be reduced, and a load of the stowage work can be reduced. That is, for example, when the layer group L in which the number of the goods Q are small is continuously stacked, the stowage of the layer group L is continuously completed early. Therefore, the supply pallet P0 may not be replaced in time, and in some cases, the layer group L may be waited and stowed until the supply pallet P0 is completely replaced. In contrast, since the maximum layer group and the minimum layer group are alternatively stacked, it is possible to reduce a standby opportunity until the supply pallet P0 is completely replaced.

[0108]

The initial solution calculation unit 32 performs the above-described process on all of the pallets P to set the stacking information for all of the pallets P.

[0109]

(Setting Flow of Stowage Information)

A process flow of setting the stowage information in the initial solution described above will be described. FIG. 18 is a flowchart for describing the process flow of setting the stowage information. As illustrated in FIG. 18, the initial solution calculation unit 32 sets the layer group L including the individual goods as the uppermost layer group, and sets the heaviest layer group as the lowermost layer group, for the respective pallets P in which the goods information is set (Step S40). The initial

solution calculation unit 32 extracts the popular goods (Step S41), selects the first pallet including the maximum number of the popular goods and the second pallet including the minimum number of the popular goods from the respective pallets P (Step S42), and sets the lowermost layer group of the first pallet as the layer group of the popular goods and the second layer group of the second pallet as the layer group of the popular goods (Step S43). Thereafter, it is determined whether all of the pallets are completely selected as the first pallet or the second pallet for the extracted popular goods (Step S44). When all of the pallets are not completely selected (Step S44; No), the process returns to Step S42, and a process of selecting the first pallet and the second pallet is continued from the unselected pallets P. In addition, when all of the pallets are selected (Step S44; Yes), it is determined whether all of the goods Q are completely extracted as the popular goods from the respective goods Q (Step S45). When all of the goods Q are not completely extracted (Step S45; No), the process returns to Step S41, and a process of extracting the popular goods is continued from among the goods Q remaining without being extracted so far. When all of the goods Q are completely extracted (Step S45; Yes), the initial solution calculation unit 32 sets the stacking order such that the maximum layer group and the minimum layer group are alternately aligned for the respective pallets P (Step S46).

[0110]

(Setting of Stowage Order)

As described above, as the initial solution, for the respective pallets P, the initial solution calculation unit 32 sets the goods information indicating the goods Q to be stowed on the pallets P and the stacking information indicating the stacking order of the goods Q. When the stowage information in the initial solution is set, the initial solution calculation unit 32 sets the stowage order in the initial solution, which indicates the order

of carrying out the stowage work for the respective pallets P, based on the stowage information of the respective pallets P. In addition, the initial solution calculation unit 32 sets the supply pallet P0 used for supplying the goods Q to the pallet P, based on the work information (supply pallet information). Hereinafter, the configuration will be specifically described.

[0111]

The initial solution calculation unit 32 determines whether there are two pallets P to which the layers of the same type of the goods Q are allocated, based on the stowage information, and when there are two pallets P to which the layers of the same type of goods Q are allocated, the initial solution calculation unit 32 sets the stowage order of the pallets P to be continuous. That is, in this case, the stowage order is set such that the goods Q are stowed in another pallet P immediately after the goods Q are completely stowed in one pallet P to which the layers of the goods Q of the same type are allocated. In this manner, the same type of the goods Q can be supplied to two pallets P having a continuous stowage order by one supply pallet P0. Therefore, for example, the number of times of replacing the supply pallet P0 disposed in the supply pallet disposition region AR2 can be suppressed, and a work load and a work time can be reduced.

[0112]

(Selection of First Pallet)

FIG. 19 is a schematic diagram for describing the setting of the stowage order. More preferably, in the second embodiment, the initial solution calculation unit 32 extracts the popular goods (target goods) from the goods Q allocated to the pallet P of each shipping destination. As the first pallet, the initial solution calculation unit 32 extracts the pallet P in which the popular goods are allocated in the layer above the lowest layer group (layer group of the second layer group or higher) in the respective

pallets P. When there are a plurality of the pallets P to which the popular goods are allocated in the layer above the lowermost layer group, any one of the plurality of pallets P may be selected as the first pallet. Here, the popular goods refer to the goods Q in which the number of allocated shipping destinations is maximum as described above, but without being limited thereto, the popular goods may indicate the goods Q of a type selected by using any method from the goods Q allocated to the pallets P of the respective shipping destinations, and may indicate the goods Q in which the total number of the goods Q for the respective shipping destinations is maximum, for example.

[0113]

(Selection of Use Pallet for First Pallet)

The initial solution calculation unit 32 selects the supply pallet P0 (use pallet) for supplying the goods Q other than the popular goods allocated to the first pallet, based on the stowage information on the first pallet and the supply pallet information included in the work information. The initial solution calculation unit 32 selects a use pallet for supplying the goods Q other than the popular goods from each of the supply pallets P0, from the type and the number of the goods Q other than the popular goods allocated to the first pallet, which are indicated in the stowage information, and the type and the number of the goods Q to be placed on the supply pallet P0, which are indicated in the supply pallet information. More specifically, in the present embodiment, the initial solution calculation unit 32 determines whether there is the supply pallet P0 on which the same number of the goods Q (goods Q of the same type) are placed, with respect to the number of the goods Q other than the popular goods allocated to the first pallet. When there is the supply pallet P0 on which the same number of the same type of the goods Q are placed, the initial solution calculation unit 32 selects the supply pallet P0 as a use pallet for supplying the goods Q to the first pallet. When there are a plurality

of the supply pallets P0 on which the same number of the same type of goods Q are placed, any one of the supply pallets P0 may be selected as the use pallet. On the other hand, when there is no supply pallet P0 on which the same number of the goods Q of the same type are placed, as the use pallet, the initial solution calculation unit 32 selects the supply pallet P0 having the minimum number of the placed goods Q, from each of the supply pallets P0.

[0114]

When the initial solution calculation unit 32 selects the use pallet, the initial solution calculation unit 32 sets the same number of the goods Q as the number of the goods Q allocated to the first pallet, in the goods Q placed on the use pallet, as the goods Q scheduled to be supplied to the first pallet.

[0115]

The initial solution calculation unit 32 selects the use pallet for each of the goods Q other than the popular goods allocated to the first pallet by using the above-described method. With regard to the supply pallet P0 selected as the use pallet, the number obtained by subtracting the number of the goods Q scheduled to be supplied to the pallet P (here, the first pallet) from the original number of the goods Q placed on the supply pallet P0 is determined as the number of the goods Q placed on the supply pallet P0, and a process of selecting the subsequent use pallet is performed. This point is the same hereinafter.

[0116]

(Selection of Second Pallet and Setting of Stowage Order)

As the second pallet, the initial solution calculation unit 32 extracts the pallet P to which the popular goods are allocated in the lowermost layer group, from the respective pallets P. When there are a plurality of the pallets P to which the popular

goods are allocated in the lowermost layer group, any one of the plurality of pallets P may be selected as the second pallet. More specifically, in the present embodiment, when a total value of the number of the popular goods included in the lowermost layer group of the pallet P and the number of the popular goods included in the first pallet is the same as the number of the popular goods placed on the supply pallet P0 indicated in the work information (supply pallet information), the pallet P (pallet P in which the popular goods are allocated to the lowermost layer group) is selected as the second pallet. In other words, when there is the supply pallet P0 on which the same number of the popular goods as the above-described total value is placed, the initial solution calculation unit 32 selects the pallet P used for calculating the total value, as the second pallet.

[0117]

When the second pallet is selected, the initial solution calculation unit 32 determines the stowage order to carry out the stowage work for the second pallet immediately after the stowage work for the first pallet. In addition, the initial solution calculation unit 32 selects the supply pallet P0 on which the number of the popular goods the same as the total value of the number of the popular goods allocated to the first pallet and the second pallet is placed, as the use pallet for supplying the popular goods to the first pallet and the second pallet. For example, in an example in FIG. 19, the goods QD which are the popular goods are allocated to the second layer group L2 (layer above the lowest layer group) of the pallet PA, and the goods QD which are the popular goods are allocated to the lowest layer group L1 of the pallet PB. The same number (three layers) of the goods QD as the total value of the number (one layer) of the goods QD in the second layer group L2 of the pallet PA and the number (two layers) of the goods QD in the lowermost layer group L1 of the pallet PB are placed on the supply pallet P0A.

Therefore, in the example in FIG. 19, the stowage order is set such that the stowage work is carried out on the pallet PB (second pallet) immediately after the pallet PA (first pallet), and the supply pallet P0A is selected as the use pallet for supplying the goods QD to the pallets PA and PB. In this way, the supply pallet P0 in which the popular goods are exactly used up with the first pallet and the second pallet is set as the use pallet, and the first pallet and the second pallet are caused to continuously carry out the stowage work. In this manner, the supply pallet P0 in which the popular goods are used up can be diverted to the pallet P (here, the second pallet). Therefore, for example, a transport load of the supply pallet P0 can be reduced, and a work time and a work load can be preferably reduced.

[0118]

On the other hand, in the present embodiment, when there is no supply pallet P0 on which the same number of popular goods as the above-described total value is placed, the pallet P in which the number of the popular goods is maximum is selected as the second pallet, from the pallets P to which the popular goods are allocated in the lowermost layer group. The initial solution calculation unit 32 determines the stowage order such that the stowage work for the second pallet is carried out immediately after the stowage work for the first pallet. When the pallet P in which the number of popular goods is maximum is selected as the second pallet, the initial solution calculation unit 32 selects the supply pallet P0 in which the number of the placed popular goods is maximum, from the respective supply pallets P0, as the use pallet for supplying the popular goods to the first pallet and the second pallet. That is, for example, when there is no supply pallet P0A on which three layers of goods QD are placed as illustrated in FIG. 19, the supply pallet P0 on which the maximum number of the goods QD are placed is selected from the respective supply pallets P0, as the use pallet for supplying the goods

QD to the pallets PA and PB. One pallet P0 may be set as the use pallet for supplying popular goods to the first pallet and the second pallet, or the use pallet for supplying popular goods to the first pallet and the use pallet for supplying popular goods to the second pallet may be individually selected.

[0119]

In addition, with respect to the second pallet, the initial solution calculation unit 32 also selects the use pallet for supplying the goods Q other than the popular goods allocated to the second pallet to the second pallet. A method for selecting the use pallet here is the same as a method for selecting the use pallet for supplying the goods Q other than the popular goods to the first pallet, and thus, description thereof will be omitted.

[0120]

As described above, in the present embodiment, the first pallet and the second pallet are selected, the stowage order is set to carry out the stowage work for the second pallet immediately after the first pallet, and the use pallet for the first pallet and the second pallet is selected. Thereafter, the initial solution calculation unit 32 newly selects the second pallet as the first pallet, sets the goods Q included in the layer above the lowermost layer group of the newly selected first pallet (original second pallet) as the popular goods, and performs the same process as described above. The initial solution calculation unit 32 performs this process until all of the pallets are selected as the first pallet or the second pallet, thereby setting the stowage order for all of the pallets and selecting the use pallet.

[0121]

(Process Flow)

Next, a process flow of setting the stowage order and the use pallet described above will be described. FIG. 20 is a flowchart for describing the process flow of

setting the stowage order and the use pallet. As illustrated in FIG. 20, the initial solution calculation unit 32 selects the pallet P to which the layer group L including the popular goods are allocated in the layer above the lowest layer group, as the first pallet (Step S50), and selects the use pallet for supplying the goods Q other than the popular goods to the first pallet, with respect to the first pallet (Step S52). The initial solution calculation unit 32 extracts the pallet P including the popular goods in the lowest layer group (Step S54), and determines whether there is the supply pallet P0 on which the same number of the popular goods as the total value of the number of popular goods in the extracted pallet P and the first pallet is placed (Step S56). When there is the supply pallet P0 on which the same number of the popular goods as the total value is placed (Step S56; Yes), the initial solution calculation unit 32 selects the extracted pallet P as the second pallet (Step S58), and selects the supply pallet P0 on which the same number of the popular goods as the total value is placed, as the use pallet for supplying the popular goods to the first pallet and the second pallet while setting the stowage order in the order of the first pallet and the second pallet (Step S60). Thereafter, the initial solution calculation unit 32 selects the use pallet for supplying the goods other than the popular goods, with respect to the second pallet (Step S62), and when the stowage order is set for all of the pallets P (Step S64; Yes), this process ends. When the stowage order is not set for all of the pallets P (Step S64; No), the process returns to Step S52, the second pallet is set as the new first pallet, and the process is continued.

[0122]

In addition, when there is no supply pallet P0 on which the same number of the popular goods as the total value is placed (Step S56; No), as the second pallet, the initial solution calculation unit 32 selects the pallet P in which the number of the popular goods is maximum, from the extracted pallets P (Step S66). While setting the stowage order

in the order of the first pallet and the second pallet, the initial solution calculation unit 32 selects the supply pallet P0 in which the number of the placed popular goods is maximum, as the use pallet for supplying the popular goods to the first pallet and the second pallet (Step S68), and the process proceeds to Step S62.

[0123]

(Advantageous Effects)

As described above, in the second embodiment, the initial solution of the stowage order of the respective pallets P is set, based on the stowage information for the plurality of pallets P. According to the present embodiment, the initial solution of the stowage order of the pallets P is set in accordance with the type, the number, and the stacking order of the goods Q scheduled to be stowed in the respective pallets P. Therefore, the stowage plan can be suitably created in accordance with work details. Furthermore, in the present embodiment, the first pallet to which the popular goods are allocated in the layer above the lowest layer group and the second pallet to which the popular goods are allocated in the lowest layer group are continuously deployed in the stacking order. In this manner, the number of times of replacing the supply pallet P0 to be disposed in the supply pallet disposition region AR2 can be more suitably suppressed, and the work load and the work time can be reduced. In addition, in the present embodiment, the supply pallet P0 in which the popular goods are exactly used up with the first pallet and the second pallet is set as the use pallet, and the first pallet and the second pallet are caused to continuously carry out the stowage work. In this manner, the supply pallet P0 in which the popular goods are used up can be diverted to the second pallet. Therefore, for example, the transport load of the supply pallet P0 can be reduced, and the work time and the work load can be preferably reduced.

[0124]

(Third Embodiment)

Next, a third embodiment will be described. In the third embodiment, a method for setting the stowage order in the initial solution is different from that in the second embodiment. In the third embodiment, elements having the configuration common to the second embodiment will be omitted in the description.

[0125]

(Setting of Stowage Information)

In the second embodiment, when setting the stowage information in the initial solution, the initial solution calculation unit 32 sets the layer group L including the popular goods as the lowermost layer group, with respect to the first pallet in which the number of the popular goods is maximum, and sets the layer group L including the popular goods as the second layer group (second layer group from the lowest side), with respect to the second pallet in which the number of the popular goods is minimum. In contrast, in the third embodiment, the initial solution calculation unit 32 sets the layer group L including the popular goods as the lowermost layer group, with respect to the first pallet, and sets the layer group L including the popular goods as the uppermost layer group, with respect to the second pallet. The second pallet is selected as the new first pallet, the goods Q in the uppermost layer group of the new first pallet are selected as the popular goods, the pallet P including the popular goods is selected as the new second pallet, and a process of setting the popular goods of the second pallet as the lowermost layer group is repeated. Except for this point, the method for setting the stowage information is the same as that in the second embodiment, and thus, description thereof will be omitted.

[0126]

(Setting of Stowage Order)

FIG. 21 is a schematic diagram for describing the setting of the initial solution of the stowage order in the third embodiment. Even in the third embodiment, as in the first embodiment, the initial solution calculation unit 32 sets the stowage order, based on the stowage information of the respective pallets P, and preferably, sets the stowage order of the pallets P to be continuous when there are two pallets P to which the layers of the same type of goods Q are allocated. However, in the third embodiment, a more preferable method for setting the stowage order and the use pallet is different from that in the second embodiment. Hereinafter, the configuration will be specifically described.

[0127]

In the third embodiment, as the first pallet, the initial solution calculation unit 32 selects the pallet P in which the number of the goods Q included in the uppermost layer group is maximum in the respective pallets P. However, the method for selecting the first pallet is not limited thereto, and the first pallet may be selected from the respective pallets P by using any method.

[0128]

As the second pallet, the initial solution calculation unit 32 selects the pallet P in which the goods Q of the same type as the goods Q included in the uppermost layer group of the first pallet in the respective pallets P are included in the lowermost layer group. When there are a plurality of the pallets P including the goods Q of the same type as the goods Q included in the uppermost layer group of the first pallet are included in the lowermost layer group, any one of the pallets P may be selected as the second pallet.

[0129]

When the second pallet is selected, the initial solution calculation unit 32

determines the stowage order to carry out the stowage work for the second pallet immediately after the stowage work for the first pallet. Thereafter, the initial solution calculation unit 32 newly selects the second pallet as the first pallet, newly selects the second pallet including the goods Q included in the lowermost group layer in the uppermost layer group of the newly selected first pallet (original second pallet), and performs the same process as described above. The initial solution calculation unit 32 sets the stowage order for all of the pallets by performing this process until all of the pallets are selected as the first pallet or the second pallet. In this way, the stowage work is continuously carried out for the first pallet and the second pallet in which the same goods Q are included in the uppermost layer group and the lowermost layer group. In this manner, the supply pallet P0 in which the combination is completely changed to the first pallet can be diverted to the second pallet. Therefore, the number of times if continuously carrying out the stowage work by moving the supply pallet P0 from the supply pallet disposition region AR2 to another location can be reduced, and the work time and the work load can be suitably reduced.

[0130]

(Selection of Use Pallet)

When setting the stowage order, the initial solution calculation unit 32 selects the use pallet for supplying the goods Q to the respective pallets P.

[0131]

Specifically, the initial solution calculation unit 32 extracts one type of the goods Q1 from the goods Q allocated to the pallet P of each shipping destination by using any method. The initial solution calculation unit 32 extracts the pallet P in which the extracted goods Q1 are included in the lowest layer group, from the respective pallets P in which the stowage order is set, and as the first pallet, selects the pallet P in which

the number of the goods Q1 is maximum, from the pallets P in which the goods Q1 are included in the lowest layer group.

[0132]

As the second pallet, the initial solution calculation unit 32 selects the pallet P in which the goods Q1 are stowed before the first pallet and to which the goods Q1 included in a lowermost layer group of the first pallet are allocated. The initial solution calculation unit 32 determines whether there are the supply pallet P0 for placing the same number of the goods Q1 as the total value of the number of the goods Q1 in the lowermost layer group of the first pallet and the number of the goods Q1 included in the second pallet. When there is the supply pallet P0 for placing the same number of the goods Q1, the initial solution calculation unit 32 selects the supply pallet P0 as the use pallet for supplying the goods Q1 to the first pallet and the second pallet. When there is no supply pallet P0 for placing the same number of the goods Q1, another pallet P in which the goods Q1 are stowed before the first pallet and to which the goods Q1 included in the lowermost layer group of the first pallet are allocated is set as the new second pallet, and the same process is performed.

[0133]

For example, in an example in FIG. 21, the goods QD are allocated to the uppermost layer group L1 of the pallet PA, and the goods QD are allocated to the lowermost layer group L1 of the pallet PB. The same number (four layers) of the goods QD as the total value of the number (two layers) of the goods QD in the uppermost layer group L1 of the pallet PA and the number (two layers) of the goods QD in the lowermost layer group L1 of the pallet PB are placed on the supply pallet P0A. Therefore, in the example in FIG. 21, the stowage order is set to carry out the stowage work on the pallet PB (second pallet) immediately after the pallet PA (first pallet), and the supply pallet

P0A is selected as the use pallet for supplying the goods QD to the pallets PA and PB. In this way, since the supply pallet P0 in which the goods Q1 are exactly used up with the first pallet and the second pallet is set as the use pallet, the supply pallet P0 in which the goods Q1 are used up by changing the combination of a required amount of the goods Q1 to the first pallet can be diverted as the pallet P (here, the second pallet). Therefore, for example, the transport load of the supply pallet P0 can be reduced, and the work time and the work load can be suitably reduced.

[0134]

The initial solution calculation unit 32 determines whether all of the pallets P correspond to the first pallet or the second pallet, and performs the same process as described above on the pallet corresponding to the first pallet or the second pallet to allocate the use pallet. On the other hand, the use pallet is allocated to the pallet P that does not correspond to the first pallet and the second pallet by using a method described below. Hereinafter, the pallet P that does not correspond to the first pallet and the second pallet will be appropriately referred to as a remaining pallet, and a method for allocating the use pallet will be described.

[0135]

The initial solution calculation unit 32 extracts a plurality of (preferably two) the remaining pallets to which the goods Q1 are allocated, from the plurality of remaining pallets. The initial solution calculation unit 32 determines whether there is the supply pallet P0 on which the same number of the goods Q1 as the total value of the number of the goods Q1 allocated to the extracted plurality of remaining pallets is placed. When there is the supply pallet P0 on which the same number of the goods Q1 is placed, the initial solution calculation unit 32 selects the supply pallet P0 as the use pallet for supplying the goods Q1 to the plurality of extracted remaining pallets. The initial

solution calculation unit 32 repeats this process until there is no supply pallet P0 on which the same number of the goods Q1 as the total value of the number of the goods Q1 on all of the remaining pallets is placed.

[0136]

When there is the remaining pallet to which the use pallet is not allocated, the initial solution calculation unit 32 selects the supply pallet P0 on which a larger number of the goods Q1 are placed than the number of the goods Q1 allocated to the remaining pallet, as the use pallet for supplying the goods Q1 to the remaining pallet.

[0137]

The initial solution calculation unit 32 selects the use pallet for supplying the goods Q1 to the respective pallets P to which the goods Q1 are allocated, by using the above-described method. Thereafter, as the goods Q1, the initial solution calculation unit 32 newly extracts the goods Q that is not extracted as the goods Q1, from the goods Q allocated to the pallet P of each shipping destination, and performs a process of selecting the use pallet in the same manner as above. The initial solution calculation unit 32 performs this process until all of the goods Q are extracted as the goods Q1, thereby selecting the use pallet for all of the goods Q.

[0138]

(Process Flow)

Next, a process flow of setting the stowage order and setting the use pallet in the initial solution in the third embodiment described above will be described. FIG. 22 is a flowchart for describing a process flow of setting the stowage order in the third embodiment, and FIG. 23 is a flowchart for describing a process flow of setting the use pallet in the third embodiment.

[0139]

As illustrated in FIG. 22, when the stowage order is set, the initial solution calculation unit 32 selects the first pallet from the respective pallets P (Step S70), determines whether there is the pallet P in which the same goods Q as the goods Q of the uppermost layer group of the first pallet are allocated to the lowermost layer group (Step S72), and when there is the pallet P (Step S72; Yes), the initial solution calculation unit 32 selects the pallet P as the second pallet (Step S74). The initial solution calculation unit 32 sets the stowage order in the order of the first pallet and the second pallet (Step S76), and when the stowage order is completely set for all of the pallets P (Step S78; Yes), this process ends. When setting the stowage order is not completed (Step S78; No), the process returns to Step S70, and the process is repeated. In addition, when there is no pallet P in which the same goods Q as the goods Q of the uppermost layer group of the first pallet are allocated to the lowermost layer group (Step S72; No), the process proceeds to Step S78.

[0140]

As illustrated in FIG. 23, when setting the use pallet, the initial solution calculation unit 32 extracts the goods Q1, selects the first pallet in which the number of the goods Q1 included in the lowermost layer group is the maximum, from the pallets P including the goods Q1 in the lowermost layer group (Step S80), and selects the second pallet to which the goods Q1 are allocated, from the pallets P stowed before the first pallet (Step S82). The initial solution calculation unit 32 determines whether there is the supply pallet P0 on which the same number of the goods Q1 as the total value of the number of the goods Q1 in the first pallet and the second pallet is placed (Step S84), and when there is the supply pallet P0 (Step S84; Yes), the initial solution calculation unit 32 selects the supply pallet P0 as the use pallet for supplying the goods Q1 to the first pallet and the second pallet (Step S86). Furthermore, it is preferable that while the

supply pallet P0 is set as the supply pallet of the first pallet, the supply pallet P0 in which the goods Q1 are completely supplied to the first pallet is diverted to the second pallet. That is, the supply pallet P0 in which the goods Q1 are completely supplied to the first pallet serves as a supply source of the goods Q1 for the second pallet. Therefore, the supply pallet P0 can be the supply pallet for the second pallet, and is used as it is as the second pallet without changing the combination of goods. Therefore, the supply pallet P0 can be diverted as the second pallet itself. Thereafter, the process proceeds to Step S88, and when all of the pallets P are not selected as the first pallet or the second pallet (Step S88; No), the process returns to Step S80. When all of the pallets P are selected as the first pallet or the second pallet (Step S88; Yes), the process proceeds to Step S90. Even when there is no supply pallet P0 on which the same number of the goods Q1 as the total value of the number of the goods Q1 in the first pallet and the number of the goods Q1 in the second pallet is placed (Step S84; No), the process proceeds to Step S88.

[0141]

In Step S90, the initial solution calculation unit 32 extracts a plurality of remaining pallets to which the goods Q1 are allocated from the remaining pallets in which the use pallet for supplying the goods Q1 is not selected. The initial solution calculation unit 32 determines whether there is the supply pallet P0 on which the same number of the goods Q1 as the total value of the number of the goods Q1 in the plurality of remaining pallets to which the goods Q1 are allocated is placed (Step S90), and when there is the supply pallet P0 (Step S90; Yes), the initial solution calculation unit 32 selects the supply pallet P0 as the use pallet for supplying the goods Q1 to the remaining pallets (Step S92). After Step S92 is performed, the process returns to Step S90 to repeat the process until there is no supply pallet P0 on which the same number of the

goods Q1 as the total value of the number of the goods Q1 on the plurality of remaining pallets is placed, by returning to Step S90. On the other hand, when there is no supply pallet P0 on which the same number of the goods Q1 as the total value of the number of the goods Q1 in the plurality of remaining pallets is placed (Step S90; No), the initial solution calculation unit 32 selects the supply pallet P0 on which a larger number of the goods Q1 than the number of the goods Q1 allocated to the remaining pallet to which the use pallet is not allocated is placed, as the use pallet for supplying the goods Q1 to the remaining pallet (Step S94). Thereafter, when the use pallet for supplying the goods Q1 is not completely selected for all of the remaining pallets (Step S96; No), the process returns to Step S94. On the other hand, when the use pallet for supplying the goods Q1 is completely selected for all of the remaining pallets, the process proceeds to Step S98. In Step S98, when all of the goods Q are not extracted as the goods Q1 (Step S98; No), the process returns to Step S80, the new goods Q are extracted as the goods Q1, and the process is repeated. When all of the goods Q are completely extracted as the goods Q1 (Step S98; Yes), this process ends.

[0142]

In this way, in the third embodiment, the stowage work is continuously carried out for the first pallet and the second pallet in which the same goods Q are included in the uppermost layer group and the lowermost layer group. In this manner, the number of times of moving the supply pallet P0 in which changing the combination of goods is completed once, from the supply pallet disposition region AR2 to another location and continuing the stowage work can be reduced, and the work time and the work load can be suitably reduced.

[0143]

(Advantageous Effects)

As described above, the information processing method according to a first aspect of the present disclosure includes a step of acquiring the work information indicating the goods Q to be shipped to the shipping destination, a step of calculating the initial solution indicating the stowage information indicating the goods Q allocated to each of the plurality of pallets P and the stacking order of the goods Q on the pallet P, and the stowage order indicating the order of stowing the pallets P, based on the work information, a step of calculating the initial evaluation value indicating a degree of load of the shipping work in the initial solution, based on the initial solution, a step of calculating the neighborhood solution obtained by partially changing the stowage information and the stowage order, with respect to the initial solution, based on the initial solution, a step of calculating the neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution, and a step of setting the stowage information and the stowage order to be used for the stowage plan, based on the initial evaluation value and the neighborhood evaluation value. According to the present disclosure, since the neighborhood solution obtained by partially changing the initial solution is created and evaluated, the stowage plan optimized in accordance with the work details can be set, and the stowage plan can be created in accordance with the work details.

[0144]

As the information processing method according to a second aspect of the present disclosure, in the information processing method according to the first aspect, in the step of setting the stowage information and the stowage order, when the evaluation of the neighborhood evaluation value is higher than the evaluation of the initial evaluation value, the stowage information and the stowage order in the neighborhood solution are set as the solution to be used for the stowage plan. According to the

present disclosure, when the evaluation of the neighborhood solution is high, the neighborhood solution is adopted. In this manner, the stowage plan can be suitably created in accordance with a degree of load of the shipping work.

[0145]

As the information processing method according to a third aspect of the present disclosure, in the information processing method according to the first aspect or the second aspect, in the step of calculating the neighborhood solution, the plurality of neighborhood solutions in which the stowage information and the stowage order are partially different from each other are calculated, and in the step of calculating the neighborhood evaluation value, the neighborhood evaluation value is calculated for each of the neighborhood solutions. According to the present disclosure, since a plurality of the neighborhood solutions are created, the stowage plan further optimized in accordance with the work details can be set.

[0146]

As the information processing method according to a fourth aspect of the present disclosure, in the information processing method according to any one of the first to third aspects, in the step of calculating the neighborhood solution, as the neighborhood solution, at least one is calculated among the first neighborhood solution obtained by exchanging the goods Q allocated to the plurality of pallets P having the same shipping destination with each other, with respect to the stowage information in the initial solution, a second neighborhood solution obtained by changing the stacking order of the goods Q on the pallet P, with respect to the stowage information in the initial solution, a third neighborhood solution obtained by changing the order of stowing the pallets P, with respect to the stowage order in the initial solution, and a fourth neighborhood solution obtained by changing the supply pallet P0 for supplying the

goods Q allocated to the pallet P, with respect to the initial solution. According to the present disclosure, since this neighborhood solution is used, the stowage plan further optimized in accordance with the work details can be set.

[0147]

As the information processing method according to a fifth aspect of the present disclosure, in the information processing method according to any one of the first to fourth aspects, in the step of calculating the initial evaluation value and the neighborhood evaluation value, the initial evaluation value and the neighborhood evaluation value are calculated, based on at least one of the work load of the stowage device 14 that stows the goods Q on the pallet P, the work load of the moving body 12 that transports the pallet P, and the number of times (small lot consecutive number) of continuously stowing the goods Q, the number of the goods Q allocated to the pallet P being equal to or smaller than a predetermined number. According to the present disclosure, since this evaluation value is used, the stowage plan further optimized in accordance with the work details can be set.

[0148]

As the information processing method according to a sixth aspect of the present disclosure, in the information processing method according to any one of the first aspect to the fifth aspect, the information processing method further includes a step of determining whether to calculate the neighborhood solution. When it is determined not to calculate the neighborhood solution, the neighborhood solution and the neighborhood evaluation value are not calculated, and the stowage information and the stowage order in the initial solution are set as the solution to be used for the stowage plan. According to the present disclosure, it is possible to determine whether to use the neighborhood solution when necessary. Therefore, the stowage plan can be

suitably set in accordance with the work details or the calculation load.

[0149]

The stowage method according to a seventh aspect of the present disclosure includes stowing the goods Q in the plurality of pallets P, based on the stowage information and the stowage order set in the information processing method according to any one of the first aspect to the sixth aspect. According to the present disclosure, the goods Q can be suitably stowed.

[0150]

The program according to an eighth aspect of the present disclosure causes a computer to execute a process including a step of acquiring the work information indicating the goods Q to be shipped to the shipping destination, a step of calculating the initial solution indicating the stowage information indicating the goods Q allocated to each of the plurality of pallets P and the stacking order of the goods Q on the pallet P, and the stacking order of the goods Q on the pallets P, and the stowage order indicating the order of stowing the pallets P, based on the work information, a step of calculating the initial evaluation value indicating a degree of load of the shipping work in the initial solution, based on the initial solution, a step of calculating the neighborhood solution obtained by partially changing the stowage information and the stowage order, with respect to the initial solution, based on the initial solution, a step of calculating the neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution, and a step of setting the stowage information and the stowage order to be used for the stowage plan, based on the initial evaluation value and the neighborhood evaluation value. According to the present disclosure, the stowage plan can be suitably created in accordance with the work details.

[0151]

The information processing device according to a ninth aspect of the present disclosure includes the work information acquisition unit 30 that acquires the work information indicating the goods Q to be shipped to the shipping destination, the initial solution calculation unit 32 that calculates the initial solution indicating the stowage information indicating the goods Q allocated to each of the plurality of pallets P and the stacking order of the goods Q on the pallet P, stacking, and the stowage order indicating the order of stowing the pallet P, based on the work information, an initial evaluation value calculation unit 36 that calculates an initial evaluation value indicating the degree of load of shipping work in the initial solution, based on the initial solution, the neighborhood solution calculation unit 34 that calculates the neighborhood solution obtained by partially changing the stowage information and the stowage order, with respect to the initial solution, based on the initial solution, the neighborhood evaluation value calculation unit 38 that calculates the neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution, and the setting unit 40 that sets the stowage information and the stowage order to be used for the stowage plan, based on the initial evaluation value and the neighborhood evaluation value. According to the present disclosure, the stowage plan can be suitably created in accordance with the work details.

[0152]

Although the embodiments of the present disclosure have been described above, the embodiments are not limited by the details of the embodiments. In addition, the above-described configuration elements include those which can be easily assumed by those skilled in the art, those which are substantially the same, and those which have a so-called equal range. Furthermore, the above-described configuration elements can

be combined with each other as appropriate. In addition, various omissions, replacements, or modifications of the configuration elements can be made within the scope not departing from the concept of the above-described embodiments.

Reference Signs List

[0153]

1: stowage system

10: information processing device

30: work information acquisition unit

32: initial solution calculation unit

34: neighborhood solution calculation unit

36: initial evaluation value calculation unit

38: neighborhood evaluation value calculation unit

40: setting unit

P: pallet

Q: goods

Claims

[Claim 1]

An information processing method comprising:

a step of acquiring work information indicating goods to be shipped to a shipping destination;

a step of calculating an initial solution indicating stowage information indicating goods allocated to each of a plurality of pallets and a stacking order of the goods on the pallet, and a stowage order indicating an order of stowing the pallets, based on the work information;

a step of calculating an initial evaluation value indicating a degree of load of shipping work in the initial solution, based on the initial solution;

a step of calculating a neighborhood solution obtained by partially changing the stowage information and the stowage order, with respect to the initial solution, based on the initial solution;

a step of calculating a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution; and

a step of setting the stowage information and the stowage order to be used for a stowage plan, based on the initial evaluation value and the neighborhood evaluation value.

[Claim 2]

The information processing method according to Claim 1,

wherein in the step of setting the stowage information and the stowage order,

when evaluation of the neighborhood evaluation value is higher than evaluation of the initial evaluation value, the stowage information and the stowage order in the neighborhood solution are set as a solution to be used for the stowage plan.

[Claim 3]

The information processing method according to Claim 1 or 2,

wherein in the step of calculating the neighborhood solution, a plurality of the neighborhood solutions in which the stowage information and the stowage order are partially different from each other are calculated, and

in the step of calculating the neighborhood evaluation value, the neighborhood evaluation value is calculated for each of the neighborhood solutions.

[Claim 4]

The information processing method according to Claim 1 or 2,

wherein in the step of calculating the neighborhood solution, as the neighborhood solution, at least one is calculated among a first neighborhood solution obtained by exchanging the goods allocated to a plurality of the pallets having the same shipping destination are exchanged with each other with respect to the stowage information in the initial solution, a second neighborhood solution obtained by changing the stacking order of the goods on the pallet, with respect to the stowage information in the initial solution, a third neighborhood solution obtained by changing the order of stowing the pallets, with respect to the stowage order in the initial solution, and a fourth neighborhood solution obtained by changing a supply pallet for supplying the goods allocated to the pallet, with respect to the initial solution.

[Claim 5]

The information processing method according to Claim 1 or 2,

wherein in the step of calculating the initial evaluation value and the neighborhood evaluation value, the initial evaluation value and the neighborhood evaluation value are calculated, based on at least one of a work load of a stowage device that stows the goods on the pallet, a work load of a moving body that transports the pallet, and the number of times of continuously stowing the goods, the number of the goods allocated to the pallet being equal to or smaller than a predetermined number.

[Claim 6]

The information processing method according to Claim 1 or 2, further comprising:

a step of determining whether to calculate the neighborhood solution,

wherein when it is determined that the neighborhood solution is not calculated, the neighborhood solution and the neighborhood evaluation value are not calculated, and the stowage information and the stowage order in the initial solution are set as a solution to be used for the stowage plan.

[Claim 7]

A stowage method comprising:

a step of stowing the goods in the plurality of pallets, based on the stowage information and the stowage order which are set in the information processing method according to Claim 1 or 2.

[Claim 8]

A program that causes a computer to execute a process comprising:

a step of acquiring work information indicating goods to be shipped to a shipping destination;

a step of calculating an initial solution indicating stowage information indicating goods allocated to each of a plurality of pallets and a stacking order of the goods on the pallet, and a stowage order indicating an order of stowing the pallets, based on the work information;

a step of calculating an initial evaluation value indicating a degree of load of shipping work in the initial solution, based on the initial solution;

a step of calculating a neighborhood solution obtained by partially changing the stowage information and the stowage order, with respect to the initial solution, based on the initial solution;

a step of calculating a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution; and

a step of setting the stowage information and the stowage order to be used for a stowage plan, based on the initial evaluation value and the neighborhood evaluation value.

[Claim 9]

An information processing device comprising:

a work information acquisition unit that acquires work information indicating goods to be shipped to a shipping destination;

an initial solution calculation unit that calculates an initial solution indicating stowage information indicating goods allocated to each of a plurality of pallets and a

stacking order of the goods on the pallet, and a stowage order indicating an order of stowing the pallets, based on the work information;

an initial evaluation value calculation unit that calculates an initial evaluation value indicating a degree of load of shipping work in the initial solution, based on the initial solution;

a neighborhood solution calculation unit that calculates a neighborhood solution obtained by partially changing the stowage information and the stowage order, with respect to the initial solution, based on the initial solution;

a neighborhood evaluation value calculation unit that calculates a neighborhood evaluation value indicating a degree of load of the shipping work in the neighborhood solution, based on the neighborhood solution; and

a setting unit that sets the stowage information and the stowage order to be used for a stowage plan, based on the initial evaluation value and the neighborhood evaluation value.