SHIP ALLOCATION PLAN CREATION DEVICE, SHIP ALLOCATION PLAN CREATION METHOD, AND RECORDING MEDIUM

FIELD OF INVENTION

[0001] The present disclosure relates to a ship allocation plan creation device, a ship allocation plan creation method, and a recording medium.

BACKGROUND OF INVENTION

[0002] When transporting raw material by ship, a ship allocation plan for transport from a loading point to an unloading point is prepared. However, ship allocation plans tend to become complex, and various solution methods have been proposed.

[0003] For example, PTL 1 discloses creating a low-cost ship allocation plan.

Citation List

Patent Literature

[0004] PTL 1: Japanese Patent No. 6586945

SUMMARY OF THE INVENTION

Technical Problem

[0005] When transporting raw material by ship, attempting to suppress cost increase related to transport may result in transport of an insufficient amount of the raw material demanded on the unloading point side. Conversely, attempting to transport a sufficient amount of the raw material demanded on the unloading point side may increase the cost. For such a reason, it has been difficult to create a ship allocation plan while balancing cost with the transport of a sufficient amount of raw material demanded on the unloading point side.

[0006] In view of the foregoing problem, an object of the present disclosure is to provide a

ship allocation plan creation device, a ship allocation plan creation method, and a recording medium that enable creation of a ship allocation plan such that a difference from the raw material demanded at the unloading point decreases while suppressing cost increase.

Solution to Problem

[0007] To solve the foregoing problem, a ship allocation plan creation device according to an aspect of the present disclosure is a ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation device including: an acquisition unit configured to acquire condition information set by a user; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0008] A ship allocation plan creation device according to another aspect of the present disclosure is a ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation device including: an acceptance unit configured to accept precondition information related to the ship allocation plan; a processing unit configured to calculate a part of content related to the ship allocation plan using the precondition

information; an acquisition unit configured to acquire condition information including the content; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0009] A ship allocation plan creation method according to another aspect of the present disclosure is a ship allocation plan creation method for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation method including the steps of: acquiring condition information set by a user; setting a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; setting a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and deriving the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term

related to the second indicator decreases.

[0010] A ship allocation plan creation method according to another aspect of the present disclosure is a ship allocation plan creation method for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation method including the steps of: accepting precondition information related to the ship allocation plan; calculating a part of content related to the ship allocation plan using the precondition information; acquiring condition information including the content; setting a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; setting a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and deriving the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0011] A recording medium according to another aspect of the present disclosure is a non-transitory computer-readable recording medium on which a ship allocation plan creation program is recorded, the ship allocation plan creation program being a ship allocation plan creation program for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation program causing a computer to function as: an acquisition unit configured to acquire condition information set by a user; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter

related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0012] A recording medium according to another aspect of the present disclosure is a non-transitory computer-readable recording medium on which a ship allocation plan creation program is recorded, the ship allocation plan creation program being a ship allocation plan creation program for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation program causing a computer to function as: an acceptance unit configured to accept precondition information related to the ship allocation plan; a processing unit configured to calculate a part of content related to the ship allocation plan using the precondition information; an acquisition unit configured to acquire condition information including the content; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or

different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0013] The present disclosure can be implemented as a semiconductor integrated circuit that implements a part or all of the program, as an information processing device, or as a system including the information processing device.

Advantageous Effects of Invention

[0014] According to the ship allocation plan creation device, the ship allocation plan creation method, and the recording medium of the present disclosure, a ship allocation plan can be created such that, while the cost increase is suppressed, a difference from the raw material demanded at the unloading point decreases.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig. 1 is a schematic diagram showing an example of an overall configuration of a ship allocation plan creation system according to a first embodiment of the present disclosure.

Fig. 2 is a diagram schematically showing an example of a hardware configuration of a server device.

Fig. 3 is a block diagram showing an example of various functions of the server device.

Fig. 4 is a diagram showing an overview of an entire process of ship allocation planning.

Fig. 5 is a diagram showing an example of condition information.

Fig. 6 is a diagram showing an example of a direct transport route and an indirect transport route.

Fig. 7 is a diagram showing an example of constraint conditions.

Fig. 8 is a diagram showing the concept of obj1.

Fig. 9 is a diagram showing the concept of obj2.

Fig. 10 is a diagram showing the concept of obj3.

Fig. 11 is a diagram showing the concept of obj4.

Fig. 12 is a diagram showing calculation results corresponding to Fig. 5.

Fig. 13 is a flowchart showing an example of a procedure of ship allocation plan creation processing.

Fig. 14 is a block diagram showing an example of various functions of a server device according to a third embodiment of the present disclosure.

Fig. 15 is a diagram showing an example of precondition information.

Fig. 16 is a diagram showing an example of information set by a processing unit.

Fig. 17 is a flowchart showing an example of a procedure of ship allocation plan creation processing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] First, several aspects of the present disclosure will be described.

[0017] A ship allocation plan creation device according to a first aspect of the present disclosure is a ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation device including: an acquisition unit configured to acquire condition information set by a user; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second

indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0018] A ship allocation plan creation device according to a second aspect of the present disclosure is the device according to the first aspect, wherein the calculation unit derives the first parameter and the second parameter related to the ship allocation plan for a case where a predetermined constraint condition is satisfied and the value of the objective function is minimized.

[0019] A ship allocation plan creation device according to a third aspect of the present disclosure is the device according to the first or second aspect, wherein the objective function includes a weighted linear sum obtained by adding a term obtained by multiplying the first indicator by a first coefficient and a term obtained by multiplying the second indicator by a second coefficient.

[0020] A ship allocation plan creation device according to a fourth aspect of the present disclosure is the device according to the first or second aspect, wherein the first indicator is an indicator indicating the number of port calls of the ship at the plurality of loading points.

[0021] A ship allocation plan creation device according to a fifth aspect of the present disclosure is the device according to the first or second aspect, wherein the second indicator is an indicator indicating a value obtained by calculating, for each type of the raw material, a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, and summing the differences.

[0022] A ship allocation plan creation device according to a sixth aspect of the present disclosure is the device according to the first or second aspect, wherein: a plurality of types of the raw material are transported, each of the raw materials is divided into a plurality of groups; and the second indicator is an indicator indicating a value obtained by calculating, for each of the groups, a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, and summing the differences.

[0023] A ship allocation plan creation device according to a seventh aspect of the present disclosure is the device according to the first or second aspect, wherein: a plurality of types of the raw material are transported, a density is set for each of the types of the raw material; and the second indicator is an indicator indicating a difference between a weighted average of densities of the respective raw materials planned to be transported to the unloading point and a weighted average of densities of the respective raw materials demanded at the unloading point.

[0024] A ship allocation plan creation device according to an eighth aspect of the present disclosure is the device according to the first or second aspect, wherein the condition information includes a date on which the ship calls at the unloading point and a total amount of the raw material to be supplied by the ship to the unloading point.

[0025] A ship allocation plan creation device according to a ninth aspect of the present disclosure is the device according to the first or second aspect, wherein the objective function includes multiplying the second indicator by a coefficient less than 1.

[0026] A ship allocation plan creation device according to a tenth aspect of the present disclosure is the device according to the ninth aspect, wherein the calculation unit derives the first parameter and the second parameter such that a constraint condition related to the second indicator is satisfied and the value of the objective function decreases.

[0027] A ship allocation plan creation device according to an eleventh aspect of the present disclosure is the device according to the tenth aspect, wherein the constraint condition related to the second indicator is a lower limit value related to a match rate between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point.

[0028] A ship allocation plan creation device according to a twelfth aspect of the present disclosure is a ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation device including: an acceptance unit configured to accept precondition information related to the ship allocation plan; a processing unit configured to calculate a part of content related to the ship allocation plan using the precondition information; an acquisition unit configured to acquire condition information including the content; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0029] A ship allocation plan creation device according to a thirteenth aspect of the present disclosure is the device according to the twelfth aspect, wherein the processing unit calculates,

as the content, a port call order in which the ship calls at the plurality of unloading points and a total amount of the raw material to be supplied by the ship to each of the plurality of unloading points, using the precondition information.

[0030] A ship allocation plan creation device according to a fourteenth aspect of the present disclosure is the device according to the thirteenth aspect, wherein the port call order is information in which the ship, the plurality of unloading points at which the ship calls, and a port call date at each of the unloading points are associated with each other.

[0031] A ship allocation plan creation device according to a fifteenth aspect of the present disclosure is the device according to the thirteenth or fourteenth aspect, wherein the total amount indicates a sum total of the raw material to be supplied by the ship to one of the unloading points.

[0032] A ship allocation plan creation device according to a sixteenth aspect of the present disclosure is the device according to the thirteenth or fourteenth aspect, wherein the precondition information includes at least one of information indicating a positional relationship between the plurality of unloading points, information indicating a remaining amount in a raw material tank at each of the unloading points, and information indicating an amount of consumption of the raw material at each of the unloading points.

[0033] A ship allocation plan creation device according to a seventeenth aspect of the present disclosure is the device according to the thirteenth or fourteenth aspect, wherein the calculation unit derives, using the objective function, a port call order in which the ship calls at the plurality of loading points and an amount of each type of the raw material to be supplied by the ship to each of the plurality of unloading points.

[0034] A ship allocation plan creation device according to an eighteenth aspect of the present disclosure is the device according to the twelfth aspect, wherein: the precondition information includes first precondition information and second precondition information

different from the first precondition information; the processing unit calculates the content using the first precondition information and the second precondition information; and the calculation unit derives the first parameter and the second parameter using the content and the first precondition information.

[0035] A ship allocation plan creation device according to a nineteenth aspect of the present disclosure is the device according to the eighteenth aspect, wherein: the first precondition information includes at least one of information related to an ocean-going vessel, information related to a coastal vessel, information related to the plurality of unloading points, information related to a type of the raw material, information related to a raw material purchase amount within a predetermined period, and information related to a draft value at each of the unloading points; and the second precondition information includes at least one of information related to a positional relationship between the plurality of unloading points, information related to a remaining amount in a raw material tank at each of the unloading points, and information related to the amount of consumption of the raw material at each of the unloading points.

[0036] A ship allocation plan creation device according to a twentieth aspect of the present disclosure is the device according to the twelfth aspect, wherein: the precondition information includes first precondition information, second precondition information different from the first precondition information, and third precondition information different from the first precondition information and the second precondition information; the processing unit calculates the content using the first precondition information and the second precondition information; and the calculation unit derives the first parameter and the second parameter using the content, the first precondition information, and the third precondition information.

[0037] A ship allocation plan creation device according to a twenty-first aspect of the present disclosure is the device according to the twentieth aspect, wherein: the first

precondition information includes at least one of information related to an ocean-going vessel, information related to a coastal vessel, information related to the plurality of unloading points, information related to a type of the raw material, information related to a raw material purchase amount within a predetermined period, and information related to a draft value at each of the unloading points; the second precondition information includes at least one of information related to a positional relationship between the plurality of unloading points, information related to a remaining amount in a raw material tank at each of the unloading points, and information related to the amount of consumption of the raw material at each of the unloading points; and the third precondition information includes at least one of information related to a positional relationship between the plurality of loading points, information related to a combination of the raw material loadable at each of the loading points, information related to a lower limit value of a raw material match rate, information related to a weight of the objective function, information related to a maximum allowable value of a density error, information related to a number of types of the raw material loadable on the ship, and information related to a lower limit amount of operation related to unloading and loading of the raw material.

[0038] A ship allocation plan creation method according to a twenty-second aspect of the present disclosure is a ship allocation plan creation method for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation method including the steps of: acquiring condition information set by a user; setting a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; setting a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to

be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and deriving the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0039] A ship allocation plan creation method according to a twenty-third aspect of the present disclosure is a ship allocation plan creation method for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation method including the steps of: accepting precondition information related to the ship allocation plan; calculating a part of content related to the ship allocation plan using the precondition information; acquiring condition information including the content; setting a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; setting a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and deriving the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0040] A recording medium according to a twenty-fourth aspect of the present disclosure is a non-transitory computer-readable recording medium on which a ship allocation plan creation program is recorded, the ship allocation plan creation program being a ship allocation plan creation program for deriving a ship allocation plan for transporting a raw material from

a loading point to an unloading point by a ship, the ship allocation plan creation program causing a computer to function as: an acquisition unit configured to acquire condition information set by a user; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0041] A recording medium according to a twenty-fifth aspect of the present disclosure is a non-transitory computer-readable recording medium on which a ship allocation plan creation program is recorded, the ship allocation plan creation program being a ship allocation plan creation program for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation program causing a computer to function as: an acceptance unit configured to accept precondition information related to the ship allocation plan; a processing unit configured to calculate a part of content related to the ship allocation plan using the precondition information; an acquisition unit configured to acquire condition information including the content; a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; a second setting unit configured to set a

second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

[0042] Embodiments of the present disclosure will be described below with reference to the accompanying drawings. To facilitate understanding of the description, the same components and steps in the drawings are denoted by the same reference numerals as far as possible, and redundant description will be omitted.

[0043] --- First Embodiment ---

A first embodiment will first be described.

[0044] <Overall Configuration>

Fig. 1 is a diagram schematically showing an example of the configuration of a ship allocation plan creation system 1 according to the first embodiment. The ship allocation plan creation system 1 is a system for creating a ship allocation plan for transporting raw material from a loading point to an unloading point by ship. The loading point is a place (port) at which raw material is loaded onto a ship. For example, the type of raw material available differs depending on the loading point. The unloading point is a place (port) at which raw material that was loaded and transported on a ship is unloaded. In the present embodiment, a case where a plurality of loading points are set and a plurality of unloading points are set will be described as an example. A transshipment point may be established between a loading point and an unloading point. The transshipment point is a type of

unloading point (or loading point) and is a base where raw material can be temporarily stored or shipped out. There may be one transshipment point or a plurality of transshipment points. Furthermore, in the present embodiment, a case where raw material is transported by a plurality of ships will be described as an example. The ships include, for example, an ocean-going vessel and a coastal vessel.

[0045] Various parameters for creating the ship allocation plan will be referred to as "parameters related to the ship allocation plan". The parameters related to the ship allocation plan are various items related to the plan content of the ship allocation plan, and are set in advance as, for example, parameters related to a route and a schedule for transporting raw material from a loading point to an unloading point by ship. For example, the parameters related to the ship allocation plan are set in advance as parameters indicating the amount of a specific type of raw material to be loaded on a ship at a loading point, a date of loading, and the like. The parameters related to the ship allocation plan are not limited to the foregoing.

[0046] The ship allocation plan is created by determining the parameters related to the ship allocation plan as described above in the ship allocation plan creation system 1 described below.

[0047] As shown in Fig. 1, the ship allocation plan creation system 1 includes a server device 2 and a user terminal 3. The server device 2 and the user terminal 3 can communicate with each other via a network NT.

[0048] The server device 2 is a ship allocation plan creation device, and is an information processing device (computer) that creates a ship allocation plan using information input by the user terminal 3. The server device 2 may be of cloud type or on-premises type. In the present embodiment, a case where the server device 2 is the ship allocation plan creation device is described as an example. However, the ship allocation plan creation device is not

limited to the server device 2.

[0049] The user terminal 3 is a terminal device, and is an information processing device (computer) used by a user. For example, the user terminal 3 is a personal computer or the like. Using the user terminal 3, the user can input various types of information and instruct the server device 2 to create a ship allocation plan.

[0050] <Hardware Configuration>

Fig. 2 is a diagram schematically showing an example of a hardware configuration of the server device 2.

[0051] As shown in Fig. 2, the server device 2 includes a control device 10, a communication device 11, and a storage device 12. The control device 10 mainly includes a CPU (Central Processing Unit) 13 and a memory 14.

[0052] In the control device 10, the CPU 13 executes a predetermined program stored in the memory 14, the storage device 12, or the like, and thereby functions as various functional components to be described below. The memory 14 is a computer-readable storage medium, and may be constituted by at least one of a RAM (Random Access Memory), a ROM (Read only memory), an EPROM (Erasable Programmable ROM), an EEPROM (Electrically Erasable Programmable ROM), and the like, for example. The memory 14 can store various types of data, and stores programs and the like needed for the server device 2 to perform processing.

[0053] The communication device 11 is constituted by a communication interface or the like for communicating with external devices. The communication device 11 can communicate with the user terminal 3, for example.

[0054] The storage device 12 is a non-transitory computer-readable instruction recording medium, and is constituted by a hard disk, a solid-state drive, or the like, for example. The storage device 12 stores various programs and various types of information needed for the

control device 10 to perform processing, and also stores information about processing results. Other examples of the non-transitory computer-readable instruction recording medium include portable recording media such as a magnetic tape, a flexible disk, an optical disc, a digital versatile disc, a Blu-ray disc, a magneto-optical disc, a memory card, and a USB memory.

[0055] Note that the server device 2 may be constituted by a single information processing device or by a plurality of information processing devices. Furthermore, Fig. 2 merely shows a part of the main hardware configuration of the server device 2, and the server device 2 can include other components. For example, the server device 2 may further include an input device (not shown) and a display device (not shown). The input device is an input device (such as a keyboard and a mouse) for accepting input from the outside. The input device accepts the user's operation and inputs the operation to the server device 2. The display device is a display device (such as a display) that provides output to the outside. The display device outputs characters and images. Note that in the server device 2, the input device and the output device may be integrated (for example, a touchscreen). Like the server device 2, the user terminal 3 includes a control device (CPU and memory), a communication device, a storage device, an operation device, and a display device.

[0056] <Functional Configuration>

Fig. 3 is a block diagram showing an example of various functions of the server device 2. The ship allocation plan creation processing is performed by the functions in the respective blocks. A computer program in which functions of at least some of the functional blocks shown in Fig. 3 are implemented may be installed in the storage of one or more computers. A CPU of the one or more computers may implement the functions of the plurality of functional blocks shown in Fig. 3 by reading the computer program installed on the computer(s) into a main memory and executing the computer program.

[0057] Furthermore, the functions of the functional blocks shown in Fig. 3 may be performed by one computer, or they may be performed by a plurality of computers in a distributed manner. In a case where the functions of the functional blocks shown in Fig. 3 are performed by a plurality of computers in a distributed manner, the plurality of computers may transmit and receive data via a communication network including a LAN (Local Area Network), a WAN (Wide Area Network), or the Internet.

[0058] As shown in Fig. 3, the server device 2 includes, as its functional configuration, an acquisition unit 21, a setting unit 22, a calculation unit 23, and an output unit 24 as the main components.

[0059] In the following description, a function to be calculated by the calculation unit 23 will be referred to as an "objective function F". An unknown in the objective function F will be referred to as a "variable". That is, the variable is a target to be derived using the objective function F. Furthermore, a condition that constrains the variable will be referred to as a "constraint condition".

[0060] The acquisition unit 21 acquires information set by the user. A ship allocation plan is created by combining various parameters to be taken into consideration, such as ports and ships, types of raw material, and routes. This combining of various parameters complicates plan formulation. That is, the creation of a ship allocation plan tends to become a large-scale problem. For this reason, as shown in Fig. 4, an entire process P0 for creating a ship allocation plan is divided into first-half planning P1 and second-half planning P2.

[0061] The first-half planning P1 is a process in which the user determines the overall framework of the ship allocation plan. That is, in the first-half planning P1, the user sets various types of information as preconditions related to the ship allocation plan. The various types of information on the preconditions related to the ship allocation plan may be set by the user through the user's own deliberation, or the user may set information determined

(calculated) by another device or the like. That is, the various types of information on the preconditions related to the ship allocation plan are not limited to being set by the user through the user's own deliberation. Preconditions related to the ship allocation plan set by the user in the first-half planning P1 and the like will be referred to as "condition information". The second-half planning P2 is a process in which calculation processing is performed to derive the ship allocation plan using the condition information set in the first-half planning P1. More specifically, the acquisition unit 21 acquires the condition information related to the ship allocation plan set by the user in the first-half planning P1. As the second-half planning P2, the server device 2 then performs calculation processing using the information acquired by the acquisition unit 21.

[0062] For example, after examining and setting the condition information about the ship allocation plan, the user inputs the condition information using the user terminal 3. The acquisition unit 21 of the server device 2 thereby acquires the condition information.

[0063] Fig. 5 is a diagram showing an example of the condition information. Fig. 5 shows some of the parameters related to the ship allocation plan. For example, in Fig. 5, various items in a range 33 are parameters related to the ship allocation plan. Fig. 5 shows, as the parameters related to the ship allocation plan, a ship (ship type), a port call order, an unloading point, a port call date, an unloading amount, and procured raw material. The ship refers to ones used in the ship allocation plan. In Fig. 5, the ship lists a ship F1 to a ship Fn. n is an integer and is set based on the number of usable ships. The port call order lists the order of port calls at the unloading points, set in association with the ships. The unloading points are ports to which raw material is delivered by ship. An unloading point A1 to an unloading point Am are shown in Fig. 5. m is an integer and is set based on the number of unloading points. The port call date lists dates on which the ships call at the unloading points. The unloading amount lists the total amounts of raw material to be carried into the unloading

points. The total amount refers to the sum total of the unloading amounts of the respective types of raw material. The procured raw material lists the amounts of each of a plurality of types of raw material to be carried from the ships into the unloading points. Fig. 5 shows a raw material G1 to a raw material Gk as the procured raw material. k is an integer and is set based on the number of types of raw material.

[0064] As the condition information, the user sets information in a range 31 shown in Fig. 5, for example. That is, as the information in the range 31, the user sets ships used in the ship allocation plan, port call order, unloading points, port call dates, and unloading amounts, for example. The information in the range 31 (the condition information) is an example of preconditions of the ship allocation plan in the first-half planning P1 and the like. Note that in Fig. 5, information in a range 32 is yet to be set.

[0065] As shown in Fig. 5, conditions on the unloading point side (at least one of the pieces of information in the range 31) are preferably set as the condition information. Specifically, the condition information preferably includes a date on which a ship calls at an unloading point (the port call date in Fig. 5) and a total amount of raw material to be supplied by the ship to the unloading point (the unloading amount in Fig. 5). Setting conditions on the unloading point side as the condition information can streamline the calculation processing to be described below.

[0066] Furthermore, the condition information includes information that constrains the parameters related to the ship allocation plan. That is, when the user prescribes a restriction such as an upper limit value on each parameter, the user sets the restriction as condition information.

[0067] Returning to Fig. 3, the acquisition unit 21 thus acquires the condition information set by the user as the first-half planning P1 of the ship allocation plan. The condition information acquired by the acquisition unit 21 is output to the setting unit 22.

[0068] The setting unit 22 is a functional unit that sets the objective function F based on the condition information. For this purpose, the setting unit 22 includes a variable setting unit 25, a constraint setting unit 26, and an objective function setting unit 27. The objective function setting unit 27 includes a first setting unit 28 and a second setting unit 29.

[0069] The variable setting unit 25 sets variables of the objective function F. Specifically, the variable setting unit 25 sets the information obtained from the condition information for each parameter related to the ship allocation plan, and sets variables in the objective function F.

[0070] Specifically, among the parameters related to the ship allocation plan, the variable setting unit 25 sets parameters about which information is obtained from the condition information as "set parameters". The variable setting unit 25 then associates values obtained from the condition information with the set parameters. In such a manner, the values of the set parameters, which are some of the parameters related to the ship allocation plan, are determined.

[0071] Among the parameters related to the ship allocation plan, the variable setting unit 25 sets parameters corresponding to information not obtained from the condition information as "unset parameters". The unset parameters are parameters whose values are unknown.

[0072] The variable setting unit 25 sets the unset parameters as variables of the objective function F to be described below.

[0073] For example, in the example of Fig. 5, the variable setting unit 25 sets the condition information acquired by the acquisition unit 21 in the range 31 as set parameters. In contrast, various parameters shown in the range 32 are parameters for which the condition information did not provide any information. The variable setting unit 25 thus sets each of the parameters in the range 32 as an unset parameter.

[0074] Note that a parameter indicating whether to route via a transshipment point is

preferably included as a parameter related to the ship allocation plan. In the present embodiment, the parameter indicating whether to route via a transshipment point will be referred to as a "transshipment parameter". The transshipment parameter is set for each ship, for example. In a case where a plurality of ships are used in the ship allocation plan, transshipment parameters may be associated with all of the ships, or may be associated with some of the ships. Fig. 6 is a diagram showing a loading point, a transshipment point, and an unloading point. Fig. 6 shows a loading point T1, an unloading point A3, and a transshipment point M1, and shows a ship F1 and a ship F5. In the present embodiment, a route for transporting raw material directly from the loading point T1 to the unloading point A3 will be referred to as a "direct transport route L1". In the direct transport route L1, for example, the ship F1 transports raw material directly from the loading point T1 to the unloading point A3. A route for transporting raw material from the loading point T1 to the unloading point A3 via the transshipment point M1 will be referred to as an "indirect transport route L2". In the indirect transport route L2, for example, the ship F1 transports raw material from the loading point T1 to the transshipment point M1, and the ship F5 transports the raw material from the transshipment point M1 to the unloading point A3. Which route, the direct transport route L1 or the indirect transport route L2, is to be used can be indicated by the transshipment parameter. The transshipment parameter is a set parameter if specified in the condition information set by the user, and is an unset parameter if not specified in the condition information set by the user.

[0075] Furthermore, a parameter related to transport of raw material from a transshipment point to an unloading point is preferably included as a parameter related to the ship allocation plan. In the present embodiment, the parameter related to transport of raw material from a transshipment point to an unloading point will be referred to as a "transshipment-point-to-unloading-point transport parameter". Examples of the transshipment-point-to-unloading-

point transport parameter include a parameter indicating that raw material is transported from the transshipment point to the unloading point by a coastal vessel, a parameter indicating a total amount of raw material to be transported from the transshipment point to the unloading point, and a parameter indicating the amount of each type of raw material to be transported from the transshipment point to the unloading point. The transshipment-point-to-unloading-point transport parameter is a set parameter if specified in the condition information set by the user, and is an unset parameter if not specified in the condition information set by the user. Fig. 6 shows a case where raw material is transported from the transshipment point M1 to the unloading point A3 by the ship F5. In this case, the transshipment-point-to-unloading-point transport parameter includes, for example, at least one of a parameter indicating that the ship F5 transports raw material from the transshipment point M1 to the unloading point A3, a parameter indicating the total amount of raw material for the ship F5 to transport from the transshipment point M1 to the unloading point A3, and a parameter indicating the amount of each type of raw material for the ship F5 to transport from the transshipment point M1 to the unloading point A3.

[0076] In such a manner, each parameter related to the ship allocation plan is set as a set parameter or an unset parameter. Unset parameters are then set as variables of the objective function F.

[0077] The constraint setting unit 26 sets constraint conditions. The constraint conditions are conditions used in determining solutions for the variables set by the variable setting unit 25 using the objective function F to be described below. That is, the solutions for the variables are solutions that satisfy the constraint conditions. The constraint setting unit 26 sets the constraint conditions based on the condition information set by the user.

[0078] Fig. 7 is a diagram showing an example of the constraint conditions. Fig. 7 lists a constraint S1 to a constraint S18. The constraint S1 is a constraint condition on a total

loading amount of the ocean-going vessel. The constraint S2 is a constraint condition on a draft at the unloading point. The constraint S3 is a constraint condition on a lower limit of a raw material loading amount at the loading point. The constraint S4 is a constraint condition on a lower limit of a raw material unloading amount at the unloading point. The constraint S5 is a constraint condition on a lower limit of the raw material loading amount. The constraint S6 is a constraint condition on an upper limit of a number of types of raw material loadable on one ocean-going vessel. The constraint S7 is a constraint condition on upper and lower limits of a difference between an unloading amount and a demanded amount at each unloading point. The constraint S8 is a constraint condition on leveled carry-in of the unloading amount. The constraint S9 is a constraint condition on a total loading amount on the coastal vessel. The constraint S10 is a constraint condition on an upper limit of a raw material carry-in amount to each unloading point. The constraint S11 is a constraint condition on an upper limit of a raw material group carry-in amount to each unloading point. The constraint S12 is a constraint condition on an initial value of a raw material group tank inventory at the transshipment point. The constraint S13 is a constraint condition on upper and lower limits of the raw material group tank inventory at the transshipment point. The constraint S14 is a constraint condition on a lower limit of a monthly raw material match rate. The constraint S15 is a constraint condition on a lower limit of a monthly raw material group match rate. The constraint S16 is a constraint condition on an upper limit of a number of loading point port calls of each ocean-going vessel. The constraint S17 is a constraint condition on a lower limit of a raw material group loading amount on the coastal vessel.

[0079] Note that the constraint conditions in Fig. 7 are examples, and constraint conditions other than those in Fig. 7 may be set.

[0080] Returning to Fig. 3, the constraint conditions of the objective function F to be described below are set in such a manner.

[0081] The objective function setting unit 27 sets the objective function F. In the present embodiment, the objective function F is the function to be minimized in an optimization problem related to the creation of the ship allocation plan. The objective function F is set in advance as a function including the parameters related to the ship allocation plan.

[0082] In the present embodiment, the objective function F is given by the following Eq. (1).

[0083] [Exp. 1]

$$F = w1 \cdot obj1 + w2 \cdot obj2 + w3 \cdot obj3 + w4 \cdot obj4 \qquad (1)$$

[0084] In Eq. (1), the term w1·obj1 is a term related to cost related to transport of raw material. In contrast, the terms w2·obj2 + w3·obj3 + w4·obj4 are terms related to a difference between raw material planned to be transported to the unloading points and raw material demanded at the unloading points. In the present embodiment, the term w1·obj1 will be referred to as a "cost-related term", and the terms w2·obj2 + w3·obj3 + w4·obj4 will be referred to as "raw material difference-related terms". The objective function F is set to include a sum of the cost-related term and the raw material difference-related terms.

[0085] The first setting unit 28 sets an indicator indicating cost related to transport in the foregoing objective function F. Specifically, the first setting unit 28 sets obj1 in Eq. (1). In the present embodiment, obj1 is the "first indicator".

[0086] obj1 is an indicator indicating cost related to transport, and specifically is an indicator indicating the number of port calls of ships at each of a plurality of loading points. That is, the numbers of port calls at the loading points are calculated ship by ship, and a value obtained by summing the numbers of port calls is obj1. The sum value is a monthly (within a predetermined period) sum value, for example. Since the cost related to transport increases as the number of port calls increases, obj1 uses the number of port calls as the

indicator indicating the cost related to transport. When the number of port calls is small (when the cost is low), obj1 has a small value.

[0087] Fig. 8 is a diagram showing a calculation example of obj1. Fig. 8 shows, as an example, a case where a ship F1 and a ship F2 call at loading points. In Fig. 8, a loading point T1 to a loading point T8 are shown as the loading points. Specifically, the ship F1 calls at the loading point T2, then calls at the loading point T5, and then calls at the loading point T7. The ship F2 calls at the loading point T1, and then calls at the loading point T8. In such a case, the number of port calls of the ship F1 at loading points is 3, and the number of port calls of the ship F2 at loading points is 2. That is, obj1, which is a value obtained by summing the number of port calls of the ship F1 and the number of port calls of the ship F2, is 5. Note that the example of Fig. 8 shows a monthly state of port calls of each ship.

[0088] For a preset function of obj1, the first setting unit 28 substitutes values corresponding to the parameters set as set parameters by the variable setting unit 25 into those parameters. The first setting unit 28 sets the parameters set as set parameters by the variable setting unit 25 as fixed values. The first setting unit 28 does not substitute values corresponding to the parameters set as unset parameters by the variable setting unit 25 into those parameters. The first setting unit 28 sets the parameters set as unset parameters by the variable setting unit 25 as variables. The first setting unit 28 thereby sets obj1 corresponding to the condition information set by the user.

[0089] As described above, obj1 is a function including unset parameters as variables. obj1 is not limited to any specific function as long as unset parameters are included as variables and an indicator (value) corresponding to the states of the unset parameters is obtained.

[0090] In Eq. (1), w1 is a first coefficient and is a coefficient (constant) by which obj1 is multiplied.

[0091] The cost-related term is set by the first setting unit 28 setting obj1 in such a manner.

[0092] In the foregoing objective function F, the second setting unit 29 sets indicators indicating differences (for example, in absolute value) between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points. Specifically, the second setting unit 29 sets obj2, obj3, and obj4 in Eq. (1). That is, each of obj2, obj3, and obj4 is an indicator indicating a degree of deviation between the plan and ideal of raw material related to transport. In the present embodiment, each of obj2, obj3, and obj4 is a "second indicator".

[0093] obj2 is an indicator indicating a sum total for a case where a difference in amount between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points is calculated for each type of raw material. The sum total is a monthly (within a predetermined period) sum total, for example. Specifically, for obj2, a difference in amount between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points is calculated for each type of raw material. The sum of the calculated differences is obj2. Note that obj2 is an indicator that affects a raw material deviation rate. When a difference between the plan and ideal is large (when a degree of deviation is large), obj2 has a large value. Since the deviation rate and the match rate are in an inverse relationship, obj2 can also be said to be an indicator that affects a raw material match rate.

[0094] Fig. 9 is a diagram showing a calculation example of obj2. Fig. 9 shows a raw material G1, a raw material G2, a raw material G3, a raw material G4, and a raw material G5 as a plurality of types of raw material. Fig. 9 shows, for each raw material, an amount of raw material planned to be transported to the unloading points (a planned amount) and an amount of raw material demanded at the unloading points (a demanded amount). Note that the example of Fig. 9 shows a monthly state of each of the raw materials. For example, in

the example of Fig. 9, a difference (an absolute value) between the planned amount and the demanded amount of the raw material G1 is 7. Similarly, a difference for the raw material G2 is 5, a difference for the raw material G3 is 10, a difference for the raw material G4 is 5, and a difference for the raw material G5 is 3. In this case, obj2 is 30, which is the sum of the differences. Note that each planned amount may be equal to the demanded amount, may be less than or equal to the demanded amount, or may be greater than or equal to the demanded amount.

[0095] For a preset function of obj2, the second setting unit 29 substitutes values corresponding to the parameters set as set parameters by the variable setting unit 25 into those parameters. The second setting unit 29 sets the parameters set as set parameters by the variable setting unit 25 as fixed values. The second setting unit 29 does not substitute values corresponding to the parameters set as unset parameters by the variable setting unit 25 into those parameters. The second setting unit 29 sets the parameters set as unset parameters by the variable setting unit 25 as variables. The second setting unit 29 thereby sets obj2 corresponding to the condition information set by the user.

[0096] As described above, obj2 is a function including unset parameters as variables. obj2 is not limited to any specific function as long as unset parameters are included as variables and an indicator (value) corresponding to the states of the unset parameters is obtained.

[0097] In Eq. (1), w2 is a second coefficient and is a coefficient (constant) by which obj2 is multiplied.

[0098] obj3 is an indicator indicating a sum total of differences in amount between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points, calculated group by group. The sum total is a monthly (within a predetermined period) sum total, for example. A group is a group of raw materials (types)

having similar properties collected together. That is, a difference between a total amount of a plurality of raw materials in the same group planned to be transported to the unloading points and a total amount of the plurality of raw materials in the same group demanded at the unloading points is calculated for each group, and obj3 is calculated by summing the differences. Note that obj3 is an indicator that affects a raw material group deviation rate. When differences between the plan and the ideal are large (when degrees of deviation are large), obj3 has a large value. Since the deviation rate and the match rate are in an inverse relationship, obj3 can be said to be an indicator that affects a raw material group match rate.

[0099] Fig. 10 is a diagram showing a calculation example of obj3. Fig. 10 shows a case where a group Gr1 includes the raw material G1 and the raw material G3, and a group Gr2 includes the raw material G2, the raw material G4, and the raw material G5. Fig. 10 shows a planned amount and a demanded amount for each raw material. The example of Fig. 10 shows a monthly state of each raw material. For example, in the example of Fig. 10, in the group Gr1, the sum of the planned amount of the raw material G1 and the planned amount of the raw material G3 is 803. In the group Gr1, the sum of the demanded amount of the raw material G1 and the demanded amount of the raw material G3 is 800. That is, a difference (an absolute value) for the group Gr1 is 3. In the group Gr2, the sum of the planned amount of the raw material G2, the planned amount of the raw material G4, and the planned amount of the raw material G5 is 787. In the group Gr2, the sum of the demanded amount of the raw material G2, the demanded amount of the raw material G4, and the demanded amount of the raw material G5 is 800. That is, a difference for the group Gr2 is 13. In this case, obj3 is 16, which is the sum of the differences.

[0100] For a preset function of obj3, the second setting unit 29 substitutes values corresponding to the parameters set as set parameters by the variable setting unit 25 into those parameters. The second setting unit 29 sets the parameters set as set parameters by the

variable setting unit 25 as fixed values. The second setting unit 29 does not substitute values corresponding to the parameters set as unset parameters by the variable setting unit 25 into those parameters. The second setting unit 29 sets the parameters set as unset parameters by the variable setting unit 25 as variables. The second setting unit 29 thereby sets obj3 corresponding to the condition information set by the user.

[0101] As described above, obj3 is a function including unset parameters as variables. obj3 is not limited to any specific function as long as unset parameters are included as variables and an indicator (value) corresponding to the states of the unset parameters is obtained.

[0102] Note that in Eq. (1), w3 is a second coefficient and is a coefficient (constant) by which obj3 is multiplied.

[0103] obj4 is an indicator indicating a difference between a weighted average of the densities of the raw materials planned to be transported to the unloading points and a weighted average of the densities of the raw materials demanded at the unloading points. The difference is calculated as, for example, a monthly (or within a predetermined period) cumulative total. The densities are set for the respective raw materials type by type. The weighted averages are calculated of the densities of the raw materials, using the amounts of the respective raw materials as weights. That is, a weighted average is calculated based on the amount and the density of each raw material planned to be transported to unloading points, and a weighted average is calculated based on the amount and the density of each raw material demanded at the unloading point. A difference between the calculated weighted averages is obj4. When a difference between the planned weighted average and the ideal weighted average is large (when a degree of deviation is large), obj4 has a large value.

[0104] Fig. 11 is a diagram showing a calculation example of obj4. Fig. 11 shows the raw material G1, the raw material G2, the raw material G3, the raw material G4, and the raw

material G5 as the plurality of types of raw material. Fig. 11 shows, for each raw material, a density, a planned amount of the raw material, and a demanded amount of the raw material. Note that the example of Fig. 11 shows a monthly state of each raw material. With the planned amounts as weights, the weighted average of the densities is approximately 33.66. With the demanded amounts as weights, the weighted average of the densities is approximately 33.69. obj4, which is the difference between the weighted averages of the densities, is thus 0.03. Note that each planned amount may be equal to the demanded amount, may be less than or equal to the demanded amount, or may be greater than or equal to the demanded amount.

[0105] For a preset function of obj4, the second setting unit 29 substitutes values corresponding to the parameters set as set parameters by the variable setting unit 25 into those parameters. The second setting unit 29 sets the parameters set as set parameters by the variable setting unit 25 as fixed values. The second setting unit 29 does not substitute values corresponding to the parameters set as unset parameters by the variable setting unit 25 into those parameters. The second setting unit 29 sets the parameters set as unset parameters by the variable setting unit 25 as variables. The second setting unit 29 thereby sets obj4 corresponding to the condition information set by the user.

[0106] As described above, obj4 is a function including unset parameters as variables. obj4 is not limited to any specific function as long as unset parameters are included as variables and an indicator (value) corresponding to the states of the unset parameters is obtained.

[0107] In Eq. (1), w4 is a second coefficient and is a coefficient (constant) by which obj4 is multiplied.

[0108] The raw material difference-related terms are set by the second setting unit 29 setting each of obj2, obj3, and obj4 as a second indicator in such a manner.

[0109] As described above, the objective function F corresponding to the condition information is set by setting each of the indicators obj1, obj2, obj3, and obj4 based on the condition information. While a case where the raw material difference-related terms use the three indicators obj2, obj3, and obj4 has been described as an example, at least one of them may be used. Furthermore, the present embodiment has dealt with the case where the indicators obj1, obj2, obj3, and obj4 are used as shown in Eq. (1). However, the objective function F may include other indicators. For example, obj5, obj6, and the like may be set as other indicators and included in the objective function F.

[0110] As shown in Eq. (1), obj1, obj2, obj3, and obj4 are multiplied by the respective coefficients w1, w2, w3, and w4 to constitute the cost-related term and the raw material difference-related terms, which are then added together. That is, the indicators are included in the objective function F in the form of a weighted linear sum. w1, w2, w3, and w4 are set so as to balance the respective indicators obj1, obj2, obj3, and obj4. The values of the coefficients are not limited.

[0111] In the present embodiment, since each of the indicators obj1, obj2, obj3, and obj4 is defined as a function including unset parameters as variables, the objective function F is a function including unset parameters as variables. With the unset parameters included in the cost-related term as first parameters and the unset parameters included in the raw material difference-related terms as second parameters, the first parameters and the second parameters may be the same or different. Furthermore, the unset parameters included in each of obj2, obj3, and obj4 in the raw material difference-related terms may be the same as or different from each other.

[0112] In such a manner, the objective function F is set. In other words, a problem regarding the ship allocation plan is represented as the objective function F.

[0113] Returning to Fig. 3, the calculation unit 23 derives a combination of the parameters

related to the ship allocation plan such that the value of the objective function F decreases. In other words, the calculation unit 23 derives the values (solutions) of the unset parameters included as variables in the objective function F such that the value of the objective function F decreases. Specifically, the calculation unit 23 derives solutions for a case where the value of the objective function F is minimized among solutions for the variables (unset parameters) that satisfy the constraint conditions set by the constraint setting unit 26. The calculation unit 23 thus searches for and derives optimal solutions using the objective function F.

[0114] In such a manner, the calculation unit 23 derives optimal solutions of the unset parameters by applying a mathematical optimization method or a metaheuristic method with the objective function F as the minimization target.

[0115] By searching for solutions such that the value of the objective function F shown in Eq. (1) decreases, a search is performed such that each of the cost-related term and the raw material difference-related terms decreases. The solutions of the unset parameters are thus derived such that the cost for transporting raw material decreases and a difference between the planned and ideal transport of raw material to be transported is reduced.

[0116] As described above, optimal solutions of the unset parameters set as variables are derived using the objective function F. With the unset parameters set, the values of the respective parameters related to the ship allocation plan are determined, whereby the ship allocation plan is created.

[0117] Returning to Fig. 3, the output unit 24 outputs the calculation result of the calculation unit 23. For example, the output unit 24 outputs the optimal solutions of the unset parameters as the calculation result to the user terminal 3. The derived ship allocation plan is thereby provided to the user.

[0118] Fig. 12 is a diagram showing an example of the derivation result of the ship allocation plan corresponding to Fig. 5. Parameters in the range 32 that are unset in Fig. 5

are derived using the objective function F, and set with values.

[0119] The server device 2 performs the various processes as described above and derives the optimal solution of the ship allocation plan. An optimal ship allocation plan is thus created by performing the various functions.

[0120] <Processing Procedure>

Fig. 13 is a flowchart showing an example of a procedure of the ship allocation plan creation processing according to the present embodiment. Each process in the following steps is started, for example, at timing when the user sets the condition information related to the ship allocation plan as the first-half planning P1 and instructs a start of the ship allocation plan creation processing. Note that the order and content of each of the following steps can be changed as appropriate.

[0121] (Step SP10)

The acquisition unit 21 acquires the condition information. The processing then proceeds to step SP11.

[0122] (Step SP11)

The variable setting unit 25 sets variables of the objective function F. Specifically, among the parameters related to the ship allocation plan, the variable setting unit 25 sets parameters about which information is obtained from the condition information as set parameters, and sets parameters corresponding to information not obtained from the condition information as unset parameters. The variable setting unit 25 then sets the unset parameters as variables of the objective function F. The processing then proceeds to step SP12.

[0123] (Step SP12)

The constraint setting unit 26 sets constraint conditions based on the condition information. The processing then proceeds to step SP13.

[0124] (Step SP13)

The objective function setting unit 27 sets the objective function F using the set parameters and the unset parameters set by the variable setting unit 25. Specifically, the objective function F is set by the first setting unit 28 setting obj1 to set the cost-related term, and by the second setting unit 29 setting obj2, obj3, and obj4 to set the raw material difference-related terms. The processing then proceeds to step SP14.

[0125] (Step SP14)

The calculation unit 23 derives the unset parameters included as variables in the objective function F such that the value of the objective function F decreases. The processing then proceeds to step SP15.

[0126] (Step SP15)

The output unit 24 outputs the optimal solutions of the unset parameters as the calculation result to the user terminal 3.

[0127] Through the foregoing procedure, the ship allocation plan is created and provided to the user.

[0128] <Operation and Effects>

As described above, the ship allocation plan creation device (server device 2) according to the present embodiment is a ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by ship, the ship allocation plan creation device including: the acquisition unit 21 that acquires the condition information set by the user; the first setting unit 28 that sets the first indicator (obj1) using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; the second setting unit 29 that sets the second indicators (obj2, obj3, obj4) using the condition information, the second indicators being indicators that include a second parameter related to the ship allocation plan as a variable and indicate a difference between

the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and the calculation unit 23 that derives the first parameter and the second parameter related to the ship allocation plan such that the value of the objective function F including the sum of the term related to the first indicator (obj1) and the terms related to the second indicators (obj2, obj3, obj4) decreases.

[0129] With this configuration, the objective function F is set to include a sum of the first indicator (obj1), which is an indicator indicating cost related to transport, and the second indicators (obj2, obj3, obj4), which are indicators indicating a difference between the raw material planned to be transported to unloading points and the raw material demanded at the unloading points. This enables creation of a ship allocation plan such that the value of the objective function F decreases, while balancing the first indicator (obj1) and the second indicators (obj2, obj3, obj4), which are in a trade-off relationship with each other. That is, the ship allocation plan can be efficiently created such that, while the cost increase is suppressed, a difference from the raw material demanded at the unloading points decreases.

[0130] Furthermore, in the ship allocation plan creation device, the calculation unit 23 derives the first parameter and the second parameter related to the ship allocation plan for a case where a predetermined constraint condition is satisfied and the value of the objective function F is minimized.

[0131] With this configuration, since the ship allocation plan is created such that the value of the objective function F is minimized, the ship allocation plan can be created such that the first indicator (obj1) and the second indicators (obj2, obj3, obj4) are minimized in balance with each other. That is, both the cost increase can be suppressed and the difference from the raw material demanded at the unloading points can be effectively reduced.

[0132] Furthermore, in the ship allocation plan creation device, the objective function F

includes a weighted linear sum obtained by adding the term in which the first indicator (obj1) is multiplied by the first coefficient (w1) and the terms in which the second indicators (obj2, obj3, obj4) are multiplied by the second coefficients (w2, w3, w4).

[0133] With this configuration, since the first indicator (obj1) and the second indicators are included in the objective function F in the form of a weighted linear sum, a balance between the first indicator (obj1) and the second indicators (obj2, obj3, obj4) can be easily adjusted within the objective function F.

[0134] Furthermore, in the ship allocation plan creation device, the first indicator (obj1) is an indicator indicating the number of port calls of the ships at the plurality of loading points.

[0135] With this configuration, the cost related to transport can be indicated by representing the first indicator (obj1) by the number of port calls of the ships at the loading points. Indicating the cost by the number of port calls can also reduce the processing load.

[0136] Furthermore, in the ship allocation plan creation device, the second indicator (obj2) is an indicator indicating a value obtained by calculating a difference between raw material planned to be transported to the unloading points and raw material demanded at the unloading points for each type of raw material, and summing the differences.

[0137] With this configuration, the second indicator (obj2) can be represented by the difference in amount for each type of raw material.

[0138] Furthermore, in the ship allocation plan creation device, a plurality of types of raw material are transported, and each of the raw materials is divided into a plurality of groups. The second indicator (obj3) is an indicator indicating a value obtained by calculating a difference between raw material planned to be transported to the unloading points and raw material demanded at the unloading points group by group, and summing the differences.

[0139] With this configuration, the second indicator (obj3) can be expressed by the difference in the amount of raw material for each group.

[0140] Furthermore, in the ship allocation plan creation device, a plurality of types of raw material are transported, and a density is set for each of the types of raw material. The second indicator (obj4) is an indicator indicating a difference between the weighted average of the densities of the raw materials planned to be transported to the unloading points and the weighted average of the densities of the raw materials demanded at the unloading points.

[0141] With this configuration, the second indicator (obj4) can be represented by the difference in the weighted average of the densities of raw material.

[0142] Furthermore, in the ship allocation plan creation device, the condition information includes dates on which the ships call at the unloading points and total amounts of raw material to be supplied by the ships to the unloading points.

[0143] With this configuration, the ship allocation plan can be efficiently calculated since the condition information includes the dates on which the ships call at the unloading points and the total amounts of raw material to be supplied by the ships to the unloading points. In particular, by having the user set the conditions on the unloading point side as the condition information, the search space of the objective function F can be effectively limited. Furthermore, using the total amounts of raw material to be supplied by the ships to the unloading points can provide a degree of freedom in setting the amount of each type of raw material, and the ship allocation plan can be created with flexibility.

[0144]--- Second Embodiment ---

Next, a second embodiment will be described.

[0145] The second embodiment differs from the first embodiment in the objective function F. The following description focuses on differences from the first embodiment. Matters not described below in the second embodiment are the same as those in the first embodiment.

[0146] In the first embodiment, the objective function F is shown as Eq. (1). In the objective function F of Eq. (1), the objective function F is constituted by adding the cost-

related term and the raw material difference-related terms. The cost-related term and the raw material difference-related terms are in a trade-off relationship such that when one is reduced, the other increases. Since the objective function F of Eq. (1) includes the cost-related term and the raw material difference-related terms added together, the ship allocation plan can be created with a balance between the two.

[0147] On the other hand, there are cases where the difference in amount between raw material planned to be transported to the unloading points and raw material demanded at the unloading points, which is indicated by the raw material difference-related terms, does not need to be brought closer to 0 as long as the difference is less than or equal to a certain amount. In other words, there are cases where the cost-related term is preferably reduced with priority over the raw material difference-related terms.

[0148] In the present embodiment, the objective function F is thus given by the following Eq. (2).

[0149] [Exp. 2]

$$F = w1 \cdot obj1 + w2 \cdot obj2 \cdot C1 + w3 \cdot obj3 \cdot C2 + w4 \cdot obj4 \qquad (2)$$

[0150] In Eq. (2), C1 and C2 are coefficients (constants) for adjusting the values of the terms of obj2 and obj3, respectively. That is, obj2 and obj3 are multiplied by C1 and C2, respectively. C1 and C2 are set in advance as coefficients less than 1. In the present embodiment, C1 and C2 have the same value, such as 0.001. Multiplying by the coefficients less than 1 can thus reduce the effect of the term of obj2 and the term of obj3 on the objective function F.

[0151] In the present embodiment, constraint conditions related to the second indicators are set. The constraint conditions are lower limit values related to a match rate between raw material planned to be transported to the unloading points and raw material demanded at the

unloading points. That is, the constraint conditions are conditions constraining the raw material planned to be transported to the unloading points to match the raw material demanded at the unloading points to a certain extent or more. Specifically, the constraint conditions are a raw material match rate and a raw material group match rate.

[0152] For each type of raw material, the ratio of the amount of raw material planned to be transported to the unloading points to the amount of raw material demanded at the unloading points is referred to as a raw material match rate. That is, the raw material match rate is the ratio of a planned amount (actual amount) to a demanded amount (ideal amount) of raw material for each type. That is, obj2 and the raw material match rate are related to each other. As a constraint condition, a lower limit value of the raw material match rate is then set. A uniform lower limit value is set for the raw material match rate for each type. For example, the lower limit value of the raw material match rate is 70% (raw material match rate ≥ 70%). obj2 is limited by thus setting the lower limit value of the raw material match rate in the constraint conditions. For example, the raw material match rate is a monthly (within a predetermined period) match rate.

[0153] For each group, the ratio of the total amount of various types of raw material planned to be transported to the unloading points to the total amount of various types of raw material demanded at the unloading points is referred to as a raw material group match rate. That is, the raw material group match rate is the ratio of a planned total amount (actual total amount) to a demanded total amount (ideal total amount) of raw material for each group. That is, obj3 and the raw material group match rate are related to each other. Then, as a constraint condition, a lower limit value of the raw material group match rate is set. A uniform lower limit value is set for the raw material match rate for each group. For example, the lower limit value of the raw material group match rate is 90% (raw material group match rate ≥ 90%). obj3 is limited by thus setting the lower limit value of the raw material group match

rate in the constraint conditions. For example, the raw material group match rate is a monthly (within a predetermined period) match rate.

[0154] By setting the constraint conditions as described above, obj2 and obj3 are limited such that the raw material match rate is greater than or equal to the lower limit value, and the raw material group match rate is greater than or equal to the lower limit value.

[0155] With the lower limit values of the raw material match rate and the raw material group match rate set as constraint conditions, the calculation unit 23, when calculating the objective function F, searches for unset parameters such that the constraint conditions are satisfied. That is, in the ship allocation plan, the lower limit values of the raw material match rate and the raw material group match rate are ensured.

[0156] Furthermore, as expressed in Eq. (2), the effect of the terms of obj2 and obj3 on the objective function F is reduced by using C1 and C2. That is, reducing the cost-related term including obj1 is prioritized over bringing the raw material match rate and the raw material group match rate closer to 100% (over bringing obj2 or obj3 closer to 0), while the lower limit values of the raw material match rate and the raw material group match rate are ensured. A ship allocation plan can thus be created in which the cost increase is efficiently suppressed while the raw material match rate and the raw material group match rate are kept at the minimum.

[0157] <Operation and Effects>

In the ship allocation plan creation device, the objective function F includes multiplying the second indicators (obj2, obj3) by coefficients (C1, C2) that are less than 1.

[0158] With this configuration, the effect of the second indicators (obj2, obj3) on the objective function F can be reduced by multiplying the second indicators (obj2, obj3) by the coefficients (C1, C2) less than 1.

[0159] In the ship allocation plan creation device, the calculation unit 23 derives the first

parameter and the second parameter such that the constraint conditions related to the second indicators (obj2, obj3) are satisfied and the value of the objective function F decreases.

[0160] With this configuration, the ship allocation plan is created while the constraint conditions related to the second indicators (obj2, obj3) are satisfied.

[0161] In the ship allocation plan creation device, the constraint conditions related to the second indicators (obj2, obj3) are lower limit values related to a match rate between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points.

[0162] With this configuration, by setting a lower limit of the match rate between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points, the ship allocation plan is created while the lower limit of the match rate is satisfied. By combining with the coefficients (C1, C2) less than 1, reducing the first indicator (obj1) is thus prioritized over bringing the match rate closer to 100% (over reducing the second indicators obj2 and obj3), while the lower limit value of the match rate is ensured. That is, the ship allocation plan can be created to suppress the cost increase in particular.

[0163]--- Third Embodiment ---

Next, a third embodiment will be described.

[0164] As the third embodiment, differences from the first and second embodiments will mainly be described below. Matters not described below as the third embodiment are the same as those in the first and second embodiments.

[0165] The first and second embodiments have dealt with a case as an example where the process related to the creation of the ship allocation plan is divided into the first-half planning P1 and the second-half planning P2, and the user sets the condition information in the first-half planning P1. In the present embodiment, a case will be described as an example where the condition information is set by calculation processing (a processing unit 52 to be described

below) in the first-half planning P1. That is, in the first-half planning P1, which is a process for determining an overall framework of the ship allocation plan, the server device 2 determines overall framework content of the ship allocation plan.

[0166] In the following description, information indicating conditions serving as premises of the ship allocation plan will be referred to as "precondition information PR". The precondition information PR is set, for example, by the user as preconditions for creating the ship allocation plan. The precondition information PR is not limited to being set by the user through the user's own deliberation. For example, a part or all of the precondition information PR may be set by a calculation device. The precondition information PR includes "first precondition information PR0" for the first-half planning P1 and the second-half planning P2, "second precondition information PR1" for the first-half planning P1, and "third precondition information PR2" for the second-half planning P2. The first precondition information PR0 is information indicating preconditions common to the first-half planning P1 and the second-half planning P2. The second precondition information PR1 is information indicating preconditions in the first-half planning P1. The third precondition information PR2 is information indicating preconditions in the second-half planning P2.

[0167] In the present embodiment, as shown in Fig. 14, the server device 2 further includes an acceptance unit 51 and a processing unit 52.

[0168] The acceptance unit 51 accepts the precondition information PR related to the ship allocation plan. For example, the acceptance unit 51 accepts the precondition information PR, which has been set by the user, using the user terminal 3. Note that the acceptance unit 51 may accept the precondition information PR set in another device from the device.

[0169] Fig. 15 is a diagram showing an example of the precondition information PR. Fig. 15 shows an example of specific information corresponding to each of the first precondition

information PR0, the second precondition information PR1, and the third precondition information PR2.

[0170] The first precondition information PR0 includes, for example, at least one of information related to ocean-going vessels, information related to coastal vessels, information related to unloading points, information related to types of raw material, information related to a raw material purchase amount within a predetermined period (for example, a month), and information related to a draft value at each unloading point. The information related to ocean-going vessels includes, for example, at least one of the number of ocean-going vessels, the name of each ocean-going vessel, the identifier of each ocean-going vessel, and specifications of each ocean-going vessel. The information related to coastal vessels includes, for example, at least one of the number of coastal vessels, the name of each coastal vessel, the identifier of each coastal vessel, and specifications of each coastal vessel. The information related to unloading points includes, for example, at least one of the number of unloading points, the name of each unloading point, and the identifier of each unloading point. The information related to types of raw material includes, for example, at least one of the number of raw materials, the name of each raw material, the identifier of each raw material, and properties of each raw material. The raw material purchase amount within a predetermined period indicates an amount of raw material to be transported according to the ship allocation plan, and specifically indicates a total amount of raw material to be loaded at the loading points by the ocean-going vessels. The draft value at each unloading point indicates a maximum value of the draft value at the unloading point. That is, the draft value at each unloading point is related to a maximum amount of cargo on each ship at each unloading point.

[0171] The second precondition information PR1 includes, for example, at least one of information related to a positional relationship between the unloading points, information

related to a remaining amount in a raw material tank at each unloading point, and information related to the amount of consumption of raw material at each unloading point. The positional relationship between unloading points includes, for example, at least one of distance information between the unloading points and movement time information between the unloading points. The movement time information between the unloading points is, for example, a time needed for movement by ship between a first unloading point and a second unloading point. The movement time information between the unloading points includes, for example, information such as four days for movement by ship from the first unloading point to the second unloading point, three days for movement by ship from the second unloading point to the first unloading point, and the like. The reason why the time needed for movement from the first unloading point to the second unloading point and the time needed for movement from the second unloading point to the first unloading point are different is that the effect of ocean currents and the like received by the ship is reflected. That is, using the movement time information between the unloading points by ship, the influence of the surrounding environment of the ship such as ocean currents can also be taken into consideration, whereby the ship allocation plan can be derived with higher accuracy. The remaining amount in a raw material tank at each unloading point is an initial value of the raw material in the raw material tank. The amount of consumption of raw material at each unloading point is the amount of consumption (planned amount of consumption) of raw material for each predetermined period (for example, each day) at each unloading point.

[0172] The third precondition information PR2 includes, for example, at least one of information related to a positional relationship between loading points, information related to a combination of raw materials loadable at each loading point, information related to the lower limit value of the raw material match rate, information related to the weights of the objective function F, information related to the maximum allowable value of a density error,

information related to the number of types of raw material loadable on one ship, and information related to the lower limit amount of operation related to unloading and loading of raw material. The positional relationship between the loading points includes distance information between the loading points. The combination of raw materials loadable at each loading point indicates raw materials that can be loaded at each loading point, and specifically indicates the purchase amount of raw materials at each loading point. The lower limit value of the raw material match rate indicates an allowable lower limit of the raw material match rate. The weights of the objective function F refer to the coefficients (w1, w2, w3, w4) used in the objective function F. The maximum allowable value of a density error indicates a maximum value allowed for a density error related to each raw material. The number of types of raw material loadable on one ship is a setting value of the number of types of raw material that can be loaded on each ship (for example, an ocean-going vessel). The lower limit amount of operation related to unloading and loading of raw material indicates a lower limit value (allowable range) of the amount of each operation related to unloading and loading of raw material.

[0173] The information included in the first precondition information PR0 is not limited to the information exemplified above. The first precondition information PR0 may include information other than the information exemplified as the precondition information PR. The first precondition information PR0 may include, as appropriate, the information exemplified as the second precondition information PR1 and the third precondition information PR2 as far as no contradiction arises. For example, the information related to the positional relationship between the unloading points may be excluded from the second precondition information PR1 and included in the first precondition information PR0 instead.

[0174] Note that, like the information included in the first precondition information PR0, the information included in the second precondition information PR1 and the information

included in the third precondition information PR2 are not limited to the information exemplified above.

[0175] Note that the precondition information PR need only include at least one of the first precondition information PR0, the second precondition information PR1, and the third precondition information PR2.

[0176] The acceptance unit 51 accepts, for example, the precondition information PR shown in Fig. 15 from the user. The acceptance unit 51 thereby sets the accepted precondition information PR as information serving as premises for creating the ship allocation plan. For example, when the acceptance unit 51 accepts the precondition information PR, the acceptance unit 51 sets the precondition information PR as information serving as premises for creating the ship allocation plan in at least one of the first-half planning P1 and the second-half planning P2. For example, when the acceptance unit 51 accepts the second precondition information PR1, the acceptance unit 51 sets the second precondition information PR1 as information serving as premises for creating the ship allocation plan in the first-half planning P1. For example, when the acceptance unit 51 accepts the first precondition information PR0, the acceptance unit 51 sets the first precondition information PR0 as information serving as premises for creating the ship allocation plan in the first-half planning P1 and the second-half planning P2. For example, when the acceptance unit 51 accepts the third precondition information PR2, the acceptance unit 51 sets the third precondition information PR2 as information serving as premises for creating the ship allocation plan in the second-half planning P2. Note that when the acceptance unit 51 accepts the precondition information PR related to the second-half planning P2 (for example, a part of the first precondition information PR0 and the third precondition information PR2), the acceptance unit 51 does not need to set the precondition information PR related to the second-half planning P2 as information serving as premises for creating the ship allocation plan. In such a case, for

example, the precondition information PR related to the second-half planning P2 accepted by the acceptance unit 51 may be acquired by the acquisition unit 21 and set by the setting unit 22 as information serving as premises for creating the ship allocation plan in the second-half planning P2.

[0177] Returning to Fig. 14, the processing unit 52 calculates a part of content related to the ship allocation plan using the precondition information PR. Specifically, the processing unit 52 performs calculation processing corresponding to the first-half planning P1. That is, in the server device 2, the acceptance unit 51 and the processing unit 52 perform calculation related to the first-half planning P1, and the acquisition unit 21, the setting unit 22, the calculation unit 23, and the output unit 24 perform calculation related to the second-half planning P2.

[0178] Using the precondition information PR, the processing unit 52 calculates a port call order in which the ships call at the unloading points and a total amount of raw material to be supplied by the ships to each of the plurality of unloading points. Specifically, the processing unit 52 performs calculation processing using the second precondition information PR1, for example. The processing unit 52 performs calculation processing using, for example, information indicating the positional relationship between the unloading points, information indicating a remaining amount in a raw material tank at each unloading point, and information indicating the amount of consumption of raw material at each unloading point. Note that the processing unit 52 may use other precondition information PR (for example, the first precondition information PR0).

[0179] In the following description, a port call order in which the ships call at the unloading points is referred to as an "unloading-point port call order". A total amount of raw material to be supplied by the ships to each of the plurality of unloading points is referred to as a "total amount of supply to the unloading point".

[0180] The unloading-point port call order is information in which the ships, the plurality of unloading points at which the ships call, and a port call date at each unloading point where the ships call are associated with each other. Fig. 16 is a diagram showing an example (corresponding to Fig. 5) of information set by the processing unit 52. An example of the unloading-point port call order is the pieces of information shown in a range R1 of Fig. 16. In such a manner, the unloading-point port call order is set corresponding to each of the ships used in the ship allocation plan. The unloading points at which each ship calls are then associated with the dates on which the ship calls. Note that the order of port calls may be set by date, or may be set by number as with the "port call order" of Fig. 16. In the example of Fig. 16, the unloading-point port call order indicates that the ship F1 calls at the unloading point A1 (port call date: January 1), the unloading point A3 (port call date: January 3), and the unloading point A5 (port call date: January 7) in order.

[0181] The total amount of supply to the unloading point indicates a sum total of raw material to be supplied by ship to one unloading point. The total amount of supply to the unloading point may be, for example, a sum total of a single type of raw material to be supplied by ship to one unloading point, or a sum total of a plurality of types of raw material to be supplied by ship to one unloading point. An example of the total amount of supply to the unloading point is the pieces of information shown in a range R2 of Fig. 16. In such a manner, the total amount of supply to the unloading point is set for each ship and each unloading point. In the example of Fig. 16, the total amount of supply to the unloading point indicates that the ship F1 supplies an unloading amount "300" of raw material to the unloading point A1, an unloading amount "500" of raw material to the unloading point A3, and an unloading amount "200" of raw material to the unloading point A5.

[0182] In such a manner, the processing unit 52 calculates the unloading-point port call order and the total amount of supply to the unloading point for the first-half planning P1 using

the precondition information PR. The processing unit 52 preferably calculates the unloading-point port call order and the total amount of supply to the unloading point by optimization calculation. For example, the processing unit 52 calculates the unloading-point port call order and the total amount of supply to the unloading point using the second precondition information PR1 such that the cost increase is suppressed. Furthermore, information in which a plurality of patterns of the unloading-point port call order and the total amount of supply to the unloading point are associated with the second precondition information PR1 in advance may be set, and the processing unit 52 may perform processing using the information. Note that the specific calculation method in the processing unit 52 is not limited.

[0183] As described above, the processing unit 52 calculates the unloading-point port call order and the total amount of supply to the unloading point using the precondition information PR. These conditions on the unloading point side are the content calculated by the processing unit 52 using the precondition information PR. That is, the processing unit 52 calculates a part of the content related to the ship allocation plan using the precondition information PR related to the ship allocation plan. The processing unit 52 can thereby calculate the conditions on the unloading points, which are supply destinations of raw material in the second-half planning P2. The calculation processing of the second-half planning P2 by the calculation unit 23 can thereby be streamlined (with a reduction in load). Specifically, in the calculation processing of the second-half planning P2 by the calculation unit 23, the number of combinations related to the calculation is reduced, and the calculation is made more efficient (faster).

[0184] After the completion of the calculation processing in the first-half planning P1, the acquisition unit 21, in the second-half planning P2, acquires the condition information including the content calculated by the processing unit 52. Specifically, the condition

information includes the unloading-point port call order and the total amounts of supply to the unloading points calculated by the processing unit 52. The condition information may include the precondition information PR (in particular, the first precondition information PR0 and the third precondition information PR2) accepted by the acceptance unit 51.

[0185] As in the embodiments described above, the setting unit 22 sets the objective function F using the condition information acquired by the acquisition unit 21. Specifically, the variable setting unit 25 in the setting unit 22 sets the unloading-point port call order and the total amounts of supply to the unloading points calculated by the processing unit 52 as set parameters. That is, in the second-half planning P2, the setting unit 22 sets the unloading-point port call order and the total amounts of supply to the unloading points, which are acquired as the condition information by the acquisition unit 21, as fixed matters for the objective function F. As a result, the unloading-point port call order and the total amounts of supply to the unloading points are treated not as variables but as fixed values in the second-half planning P2.

[0186] For example, in the objective function F of Eq. (1), the unloading-point port call order is included in the cost-related term, and the total amounts of supply to the unloading points are included in the raw material difference-related terms. The unloading-point port call order may be included in the raw material difference-related terms. The total amounts of supply to the unloading points may be included in the cost-related term.

[0187] The calculation unit 23 derives values (optimal solutions) of the unset parameters included in the objective function F, using the set objective function F. Specifically, the calculation unit 23 derives, as some of the unset parameters, a port call order in which the ships call at the loading points and the amount of each type of raw material to be supplied by ship to each of the plurality of unloading points. In the following description, the port call order in which the ships call at the loading points is referred to as a "loading-point port call

order", and the amount of each type of raw material to be supplied by ship to each of the plurality of unloading points is referred to as a "supply amount by type".

[0188] The loading-point port call order is information in which the ship, the plurality of loading points at which the ships call, and a port call date at each loading point where the ships call are associated with each other. In such a manner, the loading-point port call order is derived for each of the ships used in the ship allocation plan.

[0189] The supply amounts by type indicate the supply amounts of raw material by type for a plurality of types of raw material to be supplied by ship to one unloading point. The supply amounts by type are thus derived for each ship and each unloading point.

[0190] In the second-half planning P2, the calculation unit 23 derives the loading-point port call order and the supply amounts by type based on the unloading-point port call order and the total amounts of supply to the unloading points set in the first-half planning P1. In the example described above, the calculation unit 23 is described to derive the loading-point port call order and the supply amounts by type. However, other unset parameters related to the ship allocation plan may also be derived.

[0191] <Processing Procedure>

Fig. 17 is a flowchart showing an example of a procedure of the ship allocation plan creation processing according to the present embodiment. Each process in the following steps is started, for example, at timing when the user instructs a start of the ship allocation plan creation processing. Each process in the following steps may be started when the precondition information PR is output from another device. In the procedure of Fig. 17, description of matters similar to those in the procedure of Fig. 13 is omitted. The order and content of the following steps can be changed as appropriate.

[0192] In the procedure of Fig. 17, after the processing corresponding to the first-half planning P1 is performed, the processing corresponding to the second-half planning P2 is

performed. In the procedure of Fig. 17, the processes from step SP20 to step SP22 correspond to the first-half planning P1, and the processes from step SP10 to step SP15 correspond to the second-half planning P2.

[0193] (Step SP20)

The acceptance unit 51 accepts the precondition information PR related to the ship allocation plan. The processing then proceeds to step SP21.

[0194] (Step SP21)

The processing unit 52 calculates the unloading-point port call order and the total amounts of supply to the unloading points using the second precondition information PR1. The processing then proceeds to step SP22.

[0195] (Step SP22)

The processing unit 52 outputs the unloading-point port call order and the total amounts of supply to the unloading points to the second-half planning P2 as a calculation result of the first-half planning P1.

[0196] After the completion of the first-half planning P1, the processing proceeds to the second-half planning P2. That is, as in the procedure of Fig. 13, the processes from step SP10 to step SP15 are performed.

[0197] Specifically, in step SP10, the acquisition unit 21 acquires the condition information including the third precondition information PR2, the unloading-point port call order, and the total amounts of supply to the unloading points. In step SP11, the unloading-point port call order and the total amounts of supply to the unloading points are set as set parameters. In step SP12, the constraint conditions are set. In step SP13, the objective function F is set. In step SP14, the unset parameters are derived. In step SP14, the loading-point port call order and the supply amounts by type are derived. In step SP15, a ship allocation plan including the unloading-point port call order and the total amounts of supply to the unloading

points set in the first-half planning P1 and the loading-point port call order and the supply amounts by type set in the second-half planning P2 is output to the user terminal 3.

[0198] <Operation and Effects>

The ship allocation plan creation device (server device 2) according to the present embodiment is a ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by ship, the ship allocation plan creation device including: the acceptance unit 51 that accepts precondition information PR related to the ship allocation plan; the processing unit 52 that calculates a part of content related to the ship allocation plan using the precondition information PR; the acquisition unit 21 that acquires condition information including the content; the first setting unit 28 that sets the first indicator (obj1) using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport; the second setting unit 29 that sets the second indicators (obj2, obj3, obj4) using the condition information, the second indicators being indicators that include a second parameter related to the ship allocation plan as a variable and indicate a difference between the raw material planned to be transported to the unloading points and the raw material demanded at the unloading points, the second parameter being the same as or different from the first parameter; and the calculation unit 23 that derives the first parameter and the second parameter related to the ship allocation plan such that the value of the objective function F including the sum of the term related to the first indicator and the terms related to the second indicators decreases.

[0199] With this configuration, the ship allocation plan can be created with a balance between the first indicator (obj1) and the second indicators (obj2, obj3, obj4), which are in a trade-off relationship with each other. That is, the ship allocation plan can be efficiently created such that, while the cost increase is suppressed, a difference from the raw material

demanded at the unloading points decreases.

[0200] Furthermore, the processing unit 52 sets a part of content related to the ship allocation plan corresponding to the first-half planning P1, and using the set information, the ship allocation plan is derived using the objective function F in the second-half planning P2. This can reduce the load of the calculation processing using the objective function F. That is, the calculation using the objective function F, which is particularly prone to complication, can be prevented from becoming complicated and can be performed efficiently.

[0201] In the ship allocation plan creation device, the processing unit 52 calculates, as the content, a port call order in which the ships call at the unloading points (unloading-point port call order) and the total amount of raw material to be supplied by ship to each of the unloading points (total amount of supply to the unloading point), using the precondition information PR.

[0202] With this configuration, since the unloading-point port call order and the total amounts of supply to the unloading points are set for the first-half planning P1, the conditions on the unloading point side can be determined. That is, in the second-half planning P2 performed after the first-half planning P1, calculation can be performed in a state where the unloading-point port call order and the total amounts of supply to the unloading points are determined. A ship allocation plan can thereby be derived in which the unloading-point port call order and the total amounts of supply to the unloading points are satisfied. Furthermore, with the conditions on the unloading point side determined, resources can be allocated to a content search for a ship allocation plan that minimizes the objective function F. That is, the ship allocation plan that minimizes the objective function F can be efficiently calculated.

[0203] In the ship allocation plan creation device, the port call order (unloading-point port call order) is information in which the ships, the plurality of unloading points at which the ships call, and port call dates at the unloading points are associated with each other.

[0204] With this configuration, since the ships, the unloading points, and the port call dates

are associated with each other as the unloading-point port call order, the port call order on the unloading point side in the ship allocation plan can be appropriately set.

[0205] In the ship allocation plan creation device, the total amount (total amount of supply to the unloading point) indicates a sum total of raw material to be supplied by ship to one unloading point.

[0206] With this configuration, the overall framework of raw material supply on the unloading point side can be set by setting the total amount to be supplied to the unloading point as a sum total of raw material to be supplied by ship to one unloading point.

[0207] In the ship allocation plan creation device, the precondition information PR includes at least one of information indicating a positional relationship between the unloading points, information indicating a remaining amount in a raw material tank at each unloading point, and information indicating the amount of consumption of raw material at each unloading point.

[0208] With this configuration, the unloading-point port call order and the total amounts of supply to the unloading points can be appropriately set using the precondition information PR.

[0209] In the ship allocation plan creation device, the calculation unit 23 derives the port call order in which the ships call at the loading points (loading-point port call order) and the amount of each type of raw material to be supplied by ship to each of the plurality of unloading points (supply amount by type) using the objective function F.

[0210] With this configuration, detailed content of the ship allocation plan (the loading-point port call order and the supply amounts by type) can be set using the overall framework content (the unloading-point port call order and the total amounts of supply to the unloading points) set in the first-half planning P1. Furthermore, with the unloading-point port call order and the total amounts of supply to the unloading points set in the first-half planning P1,

the setting of the loading-point port call order and the supply amounts by type can be intensively performed in the second-half planning P2. That is, the ship allocation plan can be efficiently created such that, while the cost increase is suppressed, a difference from the raw material demanded at the unloading points decreases.

[0211] In the ship allocation plan creation device, the precondition information PR includes the first precondition information PR0 and the second precondition information PR1 different from the first precondition information PR0. The processing unit 52 calculates the content using the first precondition information PR0 and the second precondition information PR1. The calculation unit 23 derives the first parameter and the second parameter using the content and the first precondition information PR0.

[0212] With this configuration, the processing unit 52 performs calculation using the first precondition information PR0 and the second precondition information PR1 for the first-half planning P1. The calculation unit 23 performs calculation using the content determined by the processing unit 52 and the first precondition information PR0 for the second-half planning P2. Calculation can thus be performed using appropriate information at each stage while using the first precondition information PR0 as conditions common to the first-half planning P1 and the second-half planning P2. Calculation can also be performed by carrying over the content determined in the first-half planning P1 to the second-half planning P2. The creation of the ship allocation plan can thereby be efficiently performed.

[0213] In the ship allocation plan creation device, the first precondition information PR0 includes at least one of information related to ocean-going vessels, information related to coastal vessels, information related to unloading points, information related to types of raw material, information related to a raw material purchase amount within a predetermined period, and information related to a draft value at each unloading point. The second precondition information PR1 includes at least one of information related to a positional

relationship between the unloading points, information related to a remaining amount in a raw material tank at each unloading point, and information related to a consumption amount of raw material at each unloading point.

[0214] With this configuration, the first-half planning P1 and the second-half planning P2 can be appropriately performed based on the basic pieces of information related to the first precondition information PR0. In addition, the overall framework content of the ship allocation plan can be efficiently determined in the first-half planning P1 based on the specific pieces of information related to the second precondition information PR1.

[0215] In the ship allocation plan creation device, the precondition information PR includes the first precondition information PR0, the second precondition information PR1 different from the first precondition information PR0, and the third precondition information PR2 different from the first precondition information PR0 and the second precondition information PR1. The processing unit 52 calculates the content using the first precondition information PR0 and the second precondition information PR1. The calculation unit 23 derives the first parameter and the second parameter using the content, the first precondition information PR0, and the third precondition information PR2.

[0216] With this configuration, the processing unit 52 performs calculation using the first precondition information PR0, the second precondition information PR1, and the third precondition information PR2 for the first-half planning P1. The calculation unit 23 performs calculation using the content determined by the processing unit 52, the first precondition information PR0, and the third precondition information PR2 for the second-half planning P2. Calculation can thus be performed using appropriate information at each stage while using the first precondition information PR0 as conditions common to the first-half planning P1 and the second-half planning P2. Furthermore, calculation can be performed by carrying over the content determined in the first-half planning P1 to the second-

half planning P2. The creation of the ship allocation plan can thereby be efficiently performed.

[0217] In the ship allocation plan creation device, the first precondition information PR0 includes at least one of information related to ocean-going vessels, information related to coastal vessels, information related to unloading points, information related to types of raw material, information related to a raw material purchase amount within a predetermined period, and information related to a draft value at each unloading point. The second precondition information PR1 includes at least one of information related to a positional relationship between the unloading points, information related to a remaining amount in a raw material tank at each unloading point, and information related to a consumption amount of raw material at each unloading point. The third precondition information PR2 includes at least one of information related to a positional relationship between the loading points, information related to a combination of raw materials loadable at each loading point, information related to the lower limit value of the raw material match rate, information related to the weights of the objective function F, information related to a maximum allowable value of a density error, information related to the number of types of raw material loadable on one ship, and information related to the lower limit amount of operation related to unloading and loading of raw material.

[0218] With this configuration, the first-half planning P1 and the second-half planning P2 can be appropriately performed based on the basic pieces of information related to the first precondition information PR0. In addition, the overall framework content of the ship allocation plan can be efficiently determined in the first-half planning P1 based on the specific pieces of information related to the second precondition information PR1. Then, detailed content of the ship allocation plan can be appropriately determined in the second-half planning P2 based on the specific pieces of information related to the third precondition

information PR2.

[0219] <Modifications>

The present disclosure is not limited to the foregoing embodiments. That is, the foregoing embodiments to which appropriate design changes are made by those skilled in the art are also encompassed by the scope of the present disclosure as long as the embodiments include the features of the present disclosure. Furthermore, the elements of the foregoing embodiments and modifications to be described below can be combined as far as technically feasible, and combinations thereof are also encompassed by the scope of the present disclosure as long as the combinations include the features of the present disclosure.

[0220] The foregoing embodiments have dealt with a case where the functions are included in the server device 2 as an example. However, the functions may be provided in the user terminal 3. Furthermore, the functions may be distributed between the server device 2 and the user terminal 3.

[0221] The foregoing embodiments have dealt with, as an example, a case where the parameters related to the ship allocation plan are set in advance. However, the parameters related to the ship allocation plan may be automatically set. For example, parameters related to the ship allocation plan may be extracted using information related to past ship allocation plans, and the extracted parameters may be used in the ship allocation plan to be created.

[0222] The foregoing embodiments have dealt with, as an example, a case where the setting unit 22 sets unset parameters and the like as variables for the preset objective function F. However, the objective function F may be automatically generated.

[0223] The foregoing embodiments have dealt with a case where calculation is performed such that the value of the objective function F is minimized. However, the calculation is not limited to the minimizing scenario, as long as the calculation is performed such that the value of the objective function F decreases. For example, calculation may be performed such that

the value of the objective function F falls to or below a predetermined value. That is, the degree to which the ship allocation plan creation device reduces the value of the objective function F (the degree to which the ship allocation plan creation device derives suitable solutions of the unset parameters) may be appropriately set by the user, for example, based on at least one of the processing capacity of the ship allocation plan creation device, a balance between a time required for the ship allocation plan creation device to create the ship allocation plan and a desired frequency of creating the ship allocation plan, and an accuracy of the ship allocation plan desired by the user.

[0224] The foregoing embodiments have dealt with a case where C1 and C2 in Eq. (2) are set to the same value. However, C1 and C2 may be set to different values. Furthermore, the term of obj4 may be multiplied by a coefficient similar to C1 or C2. The multiplication of a term by a coefficient is not restrictive, and the term may be deleted from the objective function F.

[0225] The foregoing embodiments have dealt with, as an example, a case where the second indicators are multiplied by coefficients less than 1, using C1 and C2 in Eq. (2). However, the coefficients are not limited thereto. The coefficients less than 1 for the second indicators to be multiplied by may be, for example, the second coefficients (w2, w3, w4), by which the second indicators (obj2, obj3, obj4) are multiplied in Eq. (1). Even in such a case, the effect of a second indicator (for example, obj2) in Eq. (1) on the objective function F can be reduced by setting the second coefficient (for example, w2) corresponding to the second indicator to less than 1.

[0226] The information, the parameters, and the like described in the present disclosure may be expressed using absolute values, using relative values with respect to a predetermined value, or using other corresponding information. Mathematical expressions and the like using these parameters may be different from those explicitly disclosed in the present

disclosure.

[0227] The expression "based on" in the present disclosure does not mean "based only on", unless explicitly specified otherwise. In other words, the expression "based on" means both "based only on" and "based at least on".

[0228] The term "determining" in the present disclosure may encompass a wide variety of actions. "Determining" may include, for example, regarding judgment, calculation, computation, processing, derivation, investigation, looking up (for example, looking up in a table, a database, or another data structure), or confirmation as "determining".

"Determining" may also include, for example, regarding resolution, selection, choice, establishment, or comparison as "determined". That is, "determining" may include regarding some action as "determining".

[0229] In the present disclosure, when expressions like "obtaining information / setting information / taking information as input / using information / based on information" (including similar expressions) are used, such expressions include cases where the information itself is used, as well as cases where processed information (for example, noise-added information, normalized information, feature values extracted from information, intermediate representations of information, or the like) is used, unless explicitly specified otherwise. Furthermore, when a certain result is described to be obtained by "obtaining information / setting information / taking information as input / using information / based on information" (including similar expressions), such descriptions include cases where the result is obtained based only on the information, as well as cases where the result is obtained while being affected by information, factors, conditions, and/or states other than the information, unless explicitly specified otherwise. Furthermore, a description "information is output" (including similar expressions) includes cases where the information itself is used as output, as well as cases where processed information (for example, noise-added information,

normalized information, feature values extracted from information, intermediate representations of information, or the like) is used as output, unless explicitly specified otherwise.

CLAIMS:

1. A ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation device comprising:

an acquisition unit configured to acquire condition information set by a user;

a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport;

a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and

a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

2. The ship allocation plan creation device according to claim 1, wherein the calculation unit derives the first parameter and the second parameter related to the ship allocation plan for a case where a predetermined constraint condition is satisfied and the value of the objective function is minimized.

3. The ship allocation plan creation device according to claim 1 or 2, wherein the objective function includes a weighted linear sum obtained by adding a term obtained by multiplying the first indicator by a first coefficient and a term obtained by multiplying the second indicator by a second coefficient.

4. The ship allocation plan creation device according to claim 1 or 2, wherein the first indicator is an indicator indicating the number of port calls of the ship at the plurality of loading points.

5. The ship allocation plan creation device according to claim 1 or 2, wherein the second indicator is an indicator indicating a value obtained by calculating, for each type of the raw material, a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, and summing the differences.

6. The ship allocation plan creation device according to claim 1 or 2, wherein:

a plurality of types of the raw material are transported, and each of the raw materials is divided into a plurality of groups; and

the second indicator is an indicator indicating a value obtained by calculating, for each of the groups, a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, and summing the differences.

7. The ship allocation plan creation device according to claim 1 or 2, wherein:

a plurality of types of the raw material are transported, and a density is set for each of the types of the raw material; and

the second indicator is an indicator indicating a difference between a weighted average of densities of the respective raw materials planned to be transported to the unloading point and a weighted average of densities of the respective raw materials demanded at the unloading point.

8. The ship allocation plan creation device according to claim 1 or 2, wherein the condition information includes a date on which the ship calls at the unloading point and a total amount of the raw material to be supplied by the ship to the unloading point.

9. The ship allocation plan creation device according to claim 1 or 2, wherein the objective function includes multiplying the second indicator by a coefficient less than 1.

10. The ship allocation plan creation device according to claim 9, wherein the calculation unit derives the first parameter and the second parameter such that a constraint condition related to the second indicator is satisfied and the value of the objective function decreases.

11. The ship allocation plan creation device according to claim 10, wherein the constraint condition related to the second indicator is a lower limit value related to a match rate between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point.

12. A ship allocation plan creation device for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation device comprising:

an acceptance unit configured to accept precondition information related to the ship allocation plan;

a processing unit configured to calculate a part of content related to the ship allocation plan using the precondition information;

an acquisition unit configured to acquire condition information including the content;

a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport;

a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material

planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and

a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

13. The ship allocation plan creation device according to claim 12, wherein the processing unit calculates, as the content, a port call order in which the ship calls at the plurality of unloading points and a total amount of the raw material to be supplied by the ship to each of the plurality of unloading points, using the precondition information.

14. The ship allocation plan creation device according to claim 13, wherein the port call order is information in which the ship, the plurality of unloading points at which the ship calls, and a port call date at each of the unloading points are associated with each other.

15. The ship allocation plan creation device according to claim 13 or 14, wherein the total amount indicates a sum total of the raw material to be supplied by the ship to one of the unloading points.

16. The ship allocation plan creation device according to claim 13 or 14, wherein the precondition information includes at least one of information indicating a positional relationship between the plurality of unloading points, information indicating a remaining amount in a raw material tank at each of the unloading points, and information indicating an amount of consumption of the raw material at each of the unloading points.

17. The ship allocation plan creation device according to claim 13 or 14, wherein the calculation unit derives, using the objective function, a port call order in which the ship calls at the plurality of loading points and an amount of each type of the raw material to be supplied by the ship to each of the plurality of unloading points.

18. The ship allocation plan creation device according to claim 12, wherein:

the precondition information includes first precondition information and second precondition information different from the first precondition information;

the processing unit calculates the content using the first precondition information and the second precondition information; and

the calculation unit derives the first parameter and the second parameter using the content and the first precondition information.

19. The ship allocation plan creation device according to claim 18, wherein: the first precondition information includes at least one of information related to an ocean-going vessel, information related to a coastal vessel, information related to the plurality of unloading points, information related to a type of the raw material, information related to a raw material purchase amount within a predetermined period, and information related to a draft value at each of the unloading points; and

the second precondition information includes at least one of information related to a positional relationship between the plurality of unloading points, information related to a remaining amount in a raw material tank at each of the unloading points, and information related to an amount of consumption of the raw material at each of the unloading points.

20. The ship allocation plan creation device according to claim 12, wherein:

the precondition information includes first precondition information, second precondition information different from the first precondition information, and third precondition information different from the first precondition information and the second precondition information;

the processing unit calculates the content using the first precondition information and the second precondition information; and

the calculation unit derives the first parameter and the second parameter using the

content, the first precondition information, and the third precondition information.

21. The ship allocation plan creation device according to claim 20, wherein:

the first precondition information includes at least one of information related to an ocean-going vessel, information related to a coastal vessel, information related to the plurality of unloading points, information related to a type of the raw material, information related to a raw material purchase amount within a predetermined period, and information related to a draft value at each of the unloading points;

the second precondition information includes at least one of information related to a positional relationship between the plurality of unloading points, information related to a remaining amount in a raw material tank at each of the unloading points, and information related to an amount of consumption of the raw material at each of the unloading points; and

the third precondition information includes at least one of information related to a positional relationship between the plurality of loading points, information related to a combination of the raw material loadable at each of the loading points, information related to a lower limit value of a raw material match rate, information related to a weight of the objective function, information related to a maximum allowable value of a density error, information related to a number of types of the raw material loadable on the ship, and information related to a lower limit amount of operation related to unloading and loading of the raw material.

22. A ship allocation plan creation method for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation method comprising the steps of:

acquiring condition information set by a user;

setting a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and

indicates cost related to transport;

setting a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and

deriving the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

23. A ship allocation plan creation method for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation method comprising the steps of:

accepting precondition information related to the ship allocation plan;

calculating a part of content related to the ship allocation plan using the precondition information;

acquiring condition information including the content;

setting a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport;

setting a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and

deriving the first parameter and the second parameter related to the ship allocation

plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

24. A non-transitory computer-readable recording medium on which a ship allocation plan creation program is recorded, the ship allocation plan creation program being a ship allocation plan creation program for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation program causing a computer to function as:

an acquisition unit configured to acquire condition information set by a user;

a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport;

a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and

a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.

25. A non-transitory computer-readable recording medium on which a ship allocation plan creation program is recorded, the ship allocation plan creation program being a ship allocation plan creation program for deriving a ship allocation plan for transporting a raw material from a loading point to an unloading point by a ship, the ship allocation plan creation program causing a computer to function as:

an acceptance unit configured to accept precondition information related to the ship allocation plan;

a processing unit configured to calculate a part of content related to the ship allocation plan using the precondition information;

an acquisition unit configured to acquire condition information including the content;

a first setting unit configured to set a first indicator using the condition information, the first indicator being an indicator that includes a first parameter related to the ship allocation plan as a variable and indicates cost related to transport;

a second setting unit configured to set a second indicator using the condition information, the second indicator being an indicator that includes a second parameter related to the ship allocation plan as a variable and indicates a difference between the raw material planned to be transported to the unloading point and the raw material demanded at the unloading point, the second parameter being the same as or different from the first parameter; and

a calculation unit configured to derive the first parameter and the second parameter related to the ship allocation plan such that a value of an objective function including a sum of a term related to the first indicator and a term related to the second indicator decreases.