air in the container.

[0047]

The shipping container (1) used as a warehouse has a container body (2) in the shape of an elongated rectangular parallelepiped box. One end face of the container body (2) is open. The container refrigeration apparatus (20) is attached to block the open end of the container body (2). Space inside the container body (2) constitutes a cargo space (5) for storing cargos (6). The cargo space (5) is a storage space. The cargos (6) are boxes of the target articles (7).

[0048]

A floorboard (3) on which the cargos (6) are to be placed is disposed at the bottom of the cargo space (5). An underfloor path (4) through which air blown from the container refrigeration apparatus (20) passes is formed between the floorboard (3) and a bottom plate of the container body (2). The underfloor path (4) extends along the bottom plate of the container body (2) in the longitudinal direction of the container body (2). One end of the underfloor path (4) is connected to an outlet (34) of the container refrigeration apparatus (20), and the other end communicates with a space above the floorboard (3) (i.e., the space for storing the cargos (6)).

[0049]

–Container Refrigeration Apparatus–

As illustrated in FIG. 1, the container refrigeration apparatus (20) includes a casing (30), a refrigerant circuit (21) that performs a refrigeration cycle, an external fan (26), an internal fan (27), and an operation panel (80).

[0050]

<Casing>

The casing (30) includes a casing body (31) and a backboard (32). The casing (30) is provided with the refrigerant circuit (11), the external fan (26), and the internal fan (27).

[0051]

indicating the operating state of the container refrigeration apparatus (20) and correlating with the temperature of the cargo space (5).

[0212]

<Setting Acquisition Unit>

The setting acquisition unit (103) executes third acquisition processing. The third acquisition processing is acquisition of setting information that is a set value of the "environmental index indicating the internal environment of the cargo space (5)." The third acquisition processing is a third processing step of the quality determination method.

[0213]

Specifically, the setting acquisition unit (103) acquires, via the communication unit (75), the blowout temperature set value stored in the set value storage (71a) of the container refrigeration apparatus (20). The setting acquisition unit (103) acquires the oxygen concentration set value and the carbon dioxide concentration set value stored in the set value storage (71b) of the air composition adjustment apparatus (40) via the communication unit (75). The setting acquisition unit (103) outputs the acquired blowout temperature set value, oxygen concentration set value, and carbon dioxide concentration set value in association with times at which these set values were acquired.

[0214]

<Learning Unit>

The learning unit (104) performs so-called machine learning. The learning unit (104) executes learning processing. The learning processing is generation of state estimation models (111 to 113). The learning processing is a learning step of the quality determination method.

[0215]

The state estimation models (111 to 113) are models that have learned a correlation between the state index acquired by the state acquisition unit (101), the environmental

environmental information by the information acquisition unit (102)" and "times when the information acquisition unit (102) acquired the measurements."

[0223]

The learning information storage (121) further stores, as the learning information, data that associates "the blowout temperature set value, the oxygen concentration set value, and the carbon dioxide concentration set value acquired as the setting information by the setting acquisition unit (103)" with "times when the setting acquisition unit (103) acquired the set values."

[0224]

<Model Storage>

The model storage (122) stores the three state estimation models (111 to 113) generated by the learning unit (104). The model storage (122) stores various parameters constituting the state estimation models (111 to 113).

[0225]

–Communication Unit–

The communication unit (75) is configured to wirelessly communicate with the container refrigeration apparatus (20), the air composition adjustment apparatus (40), and the state index sensors (15).

[0226]

–Learning Processing–

The learning processing performed by the learning unit (104) will be described below. The learning processing is a learning phase of machine learning. The learning processing according to the present embodiment is generating the first state estimation model (111) related to the blowout temperature set value, the second state estimation model (112) related to the oxygen concentration set value, and the third state estimation model (113) related to the carbon

learning, and whether the sign condition is met can be accurately determined using the calculated estimated value of the state index.

[0285]

In the quality determination apparatus (13) of the present embodiment, the inference unit (106) uses the state estimation model (111 to 113) generated by machine learning to calculate the scheduled change values of the suction temperature set value, the oxygen concentration set value, and the carbon dioxide concentration set value. Thus, according to the present embodiment, each of the suction temperature set value, the oxygen concentration set value, and the carbon dioxide concentration set value can be set to an appropriate value, keeping the target articles (7) from degradation.

[0286]

–First Variation of Fourth Embodiment–

For the environmental information acquired by the information acquisition unit (102) of the present embodiment, the measurements included in the environmental information described above are merely examples. The environmental information acquired by the information acquisition unit (102) may include, for example, a measurement of the evaporation pressure of the refrigerant in the refrigerant circuit (21), a measurement of the relative humidity of the air in the cargo space (5), and a measurement of the ethylene concentration of the air in the cargo space (5). The evaporation pressure of the refrigerant in the refrigerant circuit (21) is a physical quantity indicating the operating state of the container refrigeration apparatus (20) and correlating with the temperature of the cargo space (5). The environment information acquired by the information acquisition unit (102) may exclude some of the above-described measurements.

[0287]

When the shipping container (1) is equipped with the container refrigeration apparatus

(20) only out of the container refrigeration apparatus (20) and the air composition adjustment apparatus (40), the measurements of the oxygen concentration and the carbon dioxide concentration are excluded from the environmental information. In this case, the environmental information desirably includes a “ventilation amount of the cargo space (5).”

[0288]

–Second Variation of Fourth Embodiment–

The computer in which the quality determination program of the present embodiment is installed is not limited to the portable terminal. In the context of this specification, the “computer” refers to a “machine that stores a program describing a procedure (algorithm) of calculation and automatically executes the calculation according to the stored program.” Thus, the computer in which the quality determination program of the present embodiment is installed may be, for example, a tablet, laptop, or desktop personal computer, or a microcomputer incorporated in a controller of the container refrigeration apparatus (20).

«Other Embodiments»

The quality determination apparatus (13) of each of the first to fourth embodiments may be modified in the following manner. The following variations may be combined or replaced as needed, as long as the functions of the quality determination apparatus (13) are not impaired.

[0289]

–First Variation–

The quality determination unit (64) of each of the first to third embodiments may be configured not to execute the notification operation or the diagnosis instruction operation in the main operation. The quality determination unit (64) of each of the first to third embodiments may be configured not to execute the cause identification operation and the environment change operation in the main operation.