CLAIMS

1. A quality determination apparatus, comprising:

a state acquisition unit (75, 101) configured to acquire a state index indicating a state of a target article (7), which is fresh produce, contained in a storage space (5) where an internal environment is controlled from a state detector (15) that detects the state index; and

a main processing unit (64) configured to perform a determination operation of determining whether a sign condition indicating a sign of degradation of the target article (7) is met based on the state index acquired by the state acquisition unit (75, 101).

2. The quality determination apparatus of claim 1, wherein

when determining that the sign condition is met, the main processing unit (64) is configured to perform an environment change operation of instructing an environment adjustment apparatus (14) that adjusts the internal environment of the storage space (5) to change the internal environment of the storage space (5) in order to keep the target article (7) from degradation.

3. The quality determination apparatus of claim 1 or 2, wherein

when determining that the sign condition is met, the main processing unit (64) is configured to perform a cause identification operation of identifying, from a plurality of environmental indexes indicating the internal environment of the storage space (5), an environmental index that causes the sign of degradation of the target article (7).

4. The quality determination apparatus of any one of claims 1 to 3, wherein

when determining that the sign condition is met, the main processing unit (64) is

configured to perform a notification operation of instructing a notification device (80, 130) that notifies a human of information to notify a possibility of degradation of the target article (7).

5. The quality determination apparatus of any one of claims 1 to 4, wherein

when determining that the sign condition is met, the main processing unit (64) is configured to perform a diagnosis instruction operation of instructing an environment adjustment apparatus (14) that adjusts the internal environment of the storage space (5) to diagnose whether a component of the environment adjustment apparatus (14) functions normally.

6. The quality determination apparatus of any one of claims 1 to 5, wherein

the state acquisition unit (75, 101) is configured to acquire, as the state index, an intensity of chlorophyll fluorescence of the fresh produce which is the target article (7).

7. The quality determination apparatus of claim 6, wherein

the sign condition is a condition that the intensity of chlorophyll fluorescence acquired by the state acquisition unit (75, 101) exceeds a reference fluorescence intensity, and

the main processing unit (64) is configured to set the reference fluorescence intensity based on the intensity of chlorophyll fluorescence acquired by the state acquisition unit (75, 101) when the oxygen concentration in the storage space (5) is lowered.

8. The quality determination apparatus of any one of claims 1 to 5, wherein

the sign condition is a condition that the target article (7) freezes, and

the state acquisition unit (75, 101) is configured to acquire, as the state index, whether the target article (7) has ice.

9. The quality determination apparatus of any one of claims 1 to 5, wherein

the state acquisition unit (75, 101) is configured to acquire, as the state index of the fresh produce which is the target article (7), at least one of a leakage amount of internal components of cells of the target article (7), a concentration of a stress-related plant hormone generated from the target article (7), a concentration of a substance generated by anaerobic respiration of the target article (7), a degree of internal browning of the target article (7), a concentration of phenol contained in the target article (7), a concentration of chlorogenic acid contained in the target article (7), a concentration of carotene contained in the target article (7), or pH of the target article (7).

10. A quality determination apparatus, comprising:

a state acquisition unit (75, 101) configured to acquire a state index indicating a state of a target article (7) contained in a storage space (5) where an internal environment is controlled from a state detector (15) that detects the state index;

a main processing unit (64) configured to perform a determination operation of determining whether a sign condition indicating a sign of degradation of the target article (7) is met based on the state index acquired by the state acquisition unit (75, 101);

an information acquisition unit (102) configured to acquire environmental information about the internal environment of the storage space (5);

a setting acquisition unit (103) configured to acquire setting information that is a set value of an environmental index indicating the internal environment of the storage space (5); and

a learning unit (104) configured to generate a state estimation model (111 to 113) that has learned a correlation between the state index detected by the state detector (15), the

environmental information acquired by the information acquisition unit (102), and the setting information acquired by the setting acquisition unit (103), wherein

the main processing unit (64) is configured to determine whether the sign condition is met based on an estimated value of the state index calculated by inputting the environmental information and the setting information to the state estimation model (111 to 113).

11. The quality determination apparatus of claim 10, wherein

when determining that the sign condition is met, the main processing unit (64) is configured to perform an environment change operation of instructing an environment adjustment apparatus (14) that adjusts the internal environment of the storage space (5) to change the internal environment of the storage space (5) in order to keep the target article (7) from degradation, and

in the environment change operation, the main processing unit (64) is configured to instruct the environment adjustment apparatus (14) to change the set value of the environmental index based on a result of comparison between the estimated value of the state index calculated by inputting the environment information and the setting information to the state estimation model (111 to 113) and a predetermined reference value.

12. The quality determination apparatus of claim 10 or 11, wherein

the environmental information acquired by the information acquisition unit (102) includes at least one of temperature, oxygen concentration, or carbon dioxide concentration of air in the storage space (5).

13. The quality determination apparatus of any one of claims 10 to 12, wherein

the environmental information acquired by the information acquisition unit (102)

includes a physical quantity indicating an operating state of a refrigeration apparatus (20) that adjusts a temperature of the storage space (5) and correlating with the temperature of the storage space (5).

14. The quality determination apparatus of claim 11, wherein

when the set value of the environmental index changed in the environment change operation is an abnormal value deviated from a predetermined reference range, the main processing unit (64) is configured to instruct a notification device (80, 130) that notifies a human of information to notify that the changed set value of the environmental index is abnormal.

15. A quality determination method, comprising:

a first acquisition step of acquiring a state index indicating a state of a target article (7) contained in a storage space (5) where an internal environment is controlled from a state detector (15) that detects the state index;

a second acquisition step of acquiring environmental information about the internal environment of the storage space (5);

a third acquisition step of acquiring setting information that is a set value of an environmental index indicating the internal environment of the storage space (5);

a learning step of generating a state estimation model (111 to 113) that has learned a correlation between the state index acquired in the first acquisition step, the environmental information acquired in the second acquisition step, and the setting information acquired in the third acquisition step; and

a determination step of determining whether a sign condition indicating a sign of degradation of the target article (7) is met based on an estimated value of the state index

calculated by inputting the environmental information and the setting information to the state estimation model (111 to 113).

16. The quality determination method of claim 15, further comprising

an environment change step of instructing an environment adjustment apparatus (14) that adjusts the internal environment of the storage space (5) to change the internal environment of the storage space (5) in order to keep the target article (7) from degradation when a determination is made that the sign condition is met in the determination step, wherein

in the environment change step, the environment adjustment apparatus (14) is instructed to change the set value of the environmental index based on a result of comparison between the estimated value of the state index calculated by inputting the environment information and the setting information to the state estimation model (111 to 113) and a predetermined reference value.

17. A program configured to allow a computer to execute:

first acquisition processing of acquiring a state index indicating a state of a target article (7) contained in a storage space (5) where an internal environment is controlled from a state detector (15) that detects the state index;

second acquisition processing of acquiring environmental information about the internal environment of the storage space (5);

third acquisition processing of acquiring setting information that is a set value of an environmental index indicating the internal environment of the storage space (5);

learning processing of generating a state estimation model (111 to 113) that has learned a correlation between the state index acquired in the first acquisition processing, the environmental information acquired in the second acquisition processing, and the setting

information acquired in the third acquisition processing; and

determination processing of determining whether a sign condition indicating a sign of degradation of the target article (7) is met based on an estimated value of the state index calculated by inputting the environmental information and the setting information to the state estimation model (111 to 113).

18. The program of claim 17, configured to allow the computer to execute

environment change processing of instructing an environment adjustment apparatus (14) that adjusts the internal environment of the storage space (5) to change the internal environment of the storage space (5) in order to keep the target article (7) from degradation when a determination is made that the sign condition is met in the determination processing, wherein

in the environment change processing, the environment adjustment apparatus (14) is instructed to change the set value of the environmental index based on a result of comparison between the estimated value of the state index calculated by inputting the environment information and the setting information to the state estimation model (111 to 113) and a predetermined reference value.