

A SYSTEM AND METHOD FOR TOILET ROOM MANAGEMENT EMPLOYING IoT SENSORS

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TECHNICAL CONTRIBUTION

The present disclosure relates to toilet room maintenance. More particularly, the
10 present disclosure relates to a toilet room management system and method employing
IoT sensor devices.

BACKGROUND

Sanitary ware toilet products and equipment like water taps, urinals, water closets, soap
15 dispensers, hand dryers, toilet paper roll dispensers and other toilet products operate
independently. These devices are typically not connected to any network and thus do
not provide any electronic feedback or status information to the cleaning staff and
technician staff who service the toilet rooms. The task of cleaning, diagnosing,
inspecting, and replenishing dispensable items like soap, toilet paper rolls or paper
20 towels are performed manually by the cleaning staff. Similarly, technician staff that
repair the equipment must perform walk through inspections or otherwise be alerted by
the cleaning staff to schedule repairs. As the consumption of consumables and the
cleaning needs are not precisely known, maintenance of toilet rooms can be
unpredictable leading to inconsistent results and high labor costs.

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Whenever there is a fault or breakdown (e.g., water leaks, over running faucets, no
flushing), the technicians are typically unaware until someone reports or complains
about the problem. The technicians are then deployed to identify and repair the faulty
sanitary ware equipment. A system or method with real-time information and
30 predictive capabilities is needed to better alert staff to any issue in the toilet rooms of a
facility and immediately direct technician staff or cleaning staff to get to work on
solving the faults.

SUMMARY

A first embodiment of the invention is a toilet room management system for maintaining a plurality of toilet rooms by a staff comprising: (a) a plurality of IoT sensors configured to create sensor data for calculation of a consumption status for a plurality of consumables, an environmental status for each toilet room, and a traffic pattern for each toilet room; (b) a gateway configured to receive the sensor data from each of the IoT sensors; and (c) a server in communication with the gateway and at least one user interface through a network, wherein the server includes a database. The database includes: (i) an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters; (ii) an IoT inventory for each toilet room; (iii) a staff profile for each member of the staff; (iv) a time series archive of the sensor data for each of the plurality of toilet rooms; (v) at least one consumable replenishment schedule; and (vi) at least one maintenance schedule with a plurality of task items. The server is configured to: (i) store and collate the sensor data in the time series archive; (ii) generate a plurality of task items and a plurality of reports, wherein each task item includes a current task status; (iii) monitor in real time the IoT sensors and create a plurality of urgent maintenance alerts; (iv) recommend updates for the consumable replenishment schedule and the maintenance schedule; and (v) generate screen information for the user interfaces to present the task items, the reports, and the urgent maintenance alerts; and receive data input from the staff.

A second embodiment of the invention is a method of toilet room management employing IoT sensors comprising the steps of: (a) connecting to a gateway configured to receive sensor data from a plurality of IoT sensors, wherein the IoT sensors are configured to create sensor data; (b) providing a server in communication with the gateway and at least one user interface through a network, wherein the server includes a database; and (c) performing on the server the steps of: (i) calculating a consumption status for a plurality of consumables, an environmental status for each toilet room, and a traffic pattern for each toilet room; (ii) storing and collating the sensor data in the time series archive; (iii) generating a plurality of task items and a plurality of reports, wherein each task item includes a current task status; (iv) monitoring in real time the

IoT sensors and create a plurality of urgent maintenance alerts; (v) recommending updates for the consumable replenishment schedule and the maintenance schedule; and (vi) generating screen information for the user interfaces to present the task items, the reports, and the urgent maintenance alerts, and also to receive data input from the staff.

5 The database includes: (i) an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters; (ii) an IoT inventory for each toilet room; (iii) a staff profile for each member of the staff; (iv) a time series archive of the sensor data for each of the plurality of toilet rooms; (v) at least one consumable replenishment schedule; and (vi) at least one maintenance

10 schedule with a plurality of task items.

Each IoT sensor can be in communication with the gateway via at least one of a wireless transceiver and a wired link. Also communication between the IoT sensors, the gateway, the server, and the user interfaces can be encrypted and bidirectional. For

15 instance, at least one of the IoT sensors can be configured to receive at least one command from the server through the gateway.

In addition, the gateway can include at least one of: (a) a Wi-Fi Access Point to aggregate data packet transfer to and from the server; (b) a local area network; and (c) a

20 Narrowband IoT ("NB-IoT") or 3G SIM card based mobile communication network. The IoT sensors can also be conducted via a Message Queuing Telemetry Transport.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present disclosure are described herein with reference to the

25 drawings in which:

FIG. 1 is a block diagram of a first embodiment of the invention illustrating a system including a server connected to IoT sensors through a gateway and a network.

30 **FIG. 2** is a flowchart of second embodiment of the invention illustrating the collection and analysis of IoT sensor data for management of a plurality of toilet rooms.

FIG. 3 is a dashboard screen of an embodiment of the invention providing a building management summary, a manpower management summary, and a performance index summary, as displayed on the user interface.

5 **FIG. 4** is a building management summary of an embodiment of the invention as displayed on the user interface.

FIG. 5 is a manpower management summary of an embodiment of the invention as displayed on the user interface.

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FIG. 6 is a performance index summary of an embodiment of an embodiment of the invention as displayed on the user interface.

15 **FIG. 7** is a management reports screen of an embodiment of the invention as displayed on the user interface.

FIG. 8 is a user list screen of an embodiment of the invention as displayed on the user interface.

20 **FIG. 9** is a settings screen of an embodiment of the invention as displayed on the user interface.

DETAILED DESCRIPTION

25 In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. The illustrative embodiments described in the detailed description, drawings and claims are not meant to be limiting. Other embodiments can be utilized, and other changes can be made, without departing from the spirit or scope of the subject matter presented herein. Unless specified otherwise, the terms “comprising,” “comprise,” “including” and “include” used herein, and grammatical
30 variants thereof, are intended to represent “open” or “inclusive” language such that they include recited elements but also permit inclusion of additional, un-recited elements. The term “connect,” “connected,” or “connecting” used herein, and grammatical

variants thereof, are intended to represent a linking of two items either directly together or linking them indirectly together through a wireless and/or wired network.

As used herein, the term network can be the internet, an intranet, and/or a combination
5 of the two. The network can be accomplished using any combination of Wi-Fi, WAN, LAN, cellular, wired, optical cable to communicate data from the gateway or user interface to the server.

As used herein, a server may be a single stand-alone server, multiple dedicated servers,
10 and/or a virtual server running on a larger network of servers. The database may be on the server itself or accessible to the server on a separate network or platform. Sensor data may be stored in the server or offsite on a data storage network.

The user interface may be a visual screen on a portable tablet, a smart phone, a
15 dedicated device, a laptop computer, or a desktop computer. In field usage will typically include a smaller visual screen, thus information formatting for mobile devices may differ from that shown on a laptop or desktop computer. Access levels between members of the staff may differ depending on the role such as between the cleaning staff, the technician staff, the supervisor staff, and the server administrator.

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FIG. 1 is a block diagram **1-00** of an embodiment of the system **1-01** including the IoT sensors, the gateway **10**, the network **11**, a user interface **06**, a mobile sensor **05**, and the server **12**. The toilet room **01** includes a plurality of IoT sensors falling into the categories of consumption sensors **02**, environmental sensors **03**, and traffic pattern
25 sensors **04**. The IoT sensors are connected to the server **12** through a gateway **10** and the network **11**. The user interface **06** accesses the server **12** through the network **11** and is connected to one or more mobile sensors **05**. The server **12** includes a database **13**.

30 **FIG. 2** is a flowchart **2-00** of second embodiment of the invention illustrating the collection and analysis of IoT sensor data for management of a plurality of toilet rooms

01. The flowchart 2-00 illustrates the steps 2-01 to 2-06 (see below) for implementing an embodiment of the invention.

2-01	install IoT sensor in a plurality of toilet rooms
2-02	connect a server to the IoT sensors through a gateway
2-03	populate a database with: • an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters • an IoT inventory for each toilet room • a staff profile for each member of the staff • a time series archive of the sensor data for each of the plurality of toilet rooms • at least one consumable replenishment schedule • at least one maintenance schedule with a plurality of task items
2-04	perform on the server the steps of: • calculating a consumption status for a plurality of consumables, an environmental status for each toilet room, and a traffic pattern for each toilet room • storing and collating the sensor data in the time series archive • generating a plurality of task items and a plurality of reports, wherein each task item includes a current task status • monitoring in real time the IoT sensors and create a plurality of urgent maintenance alerts • recommending updates for the consumable replenishment schedule and the maintenance schedule • generating screen information for the user interfaces to present the task items, the reports, and the urgent maintenance alerts, and also to receive data input from the staff
2-05	perform cleaning and/or maintenance at each toilet room
2-06	update database with the current task status and any mobile sensor data

FIG. 3 is a dashboard screen **3-00** of an embodiment of the invention providing a building management summary, a manpower management summary, and a performance index summary, as displayed on the user interface **06**. The building management summary of this screen includes statistics for both cleaning and maintenance. The manpower management summary includes statistics on the cleaning staff availability and the technician staff availability. The performance index summary includes a downtime metric, an index of cleanliness, a soap consumption, a paper towel consumption, a water consumption, and an energy consumption.

FIG. 4 is a building management summary screen **4-00** of an embodiment of the invention as displayed on the user interface **06**. The building management summary of this screen includes statistics for both cleaning and maintenance. Statistics from the ammonia sensors, the soap dispenser sensors, the paper towel dispenser sensors, the water tap sensors, the water closet flush sensors, the urinal flush sensors, the hand dryer watt meters, the temperature sensors, and the humidity sensors are included in the screen.

FIG. 5 is a manpower management summary screen **5-00** of an embodiment of the invention as displayed on the user interface **06**. The manpower management summary of this screen includes statistics on the cleaning staff availability and the technician staff availability.

FIG. 6 is a performance index summary screen **6-00** of an embodiment of an embodiment of the invention as displayed on the user interface **06**. The performance index summary includes a downtime metric, an equipment list, and an index of cleanliness. Metrics are also included for the soap consumption, the paper towel consumption, the water consumption, and the energy consumption.

FIG. 7 is a management reports screen **7-00** of an embodiment of the invention as displayed on the user interface **06**. The management report screen includes the equipment and the consumption information broken down by month and year.

FIG. 8 is a user list screen **8-00** of an embodiment of the invention as displayed on a user interface **06**. Users are categorized by the job designation including the cleaning staff, the technician staff, and the supervisor staff. The screen includes fields including name, username (or the staff ID), gender, the work location, date created and the actions (or task items).

FIG. 9 is a settings screen **9-00** of an embodiment of the invention as displayed on a user interface **06**. The screen includes a maintenance schedule including cleaning schedule suggestions and predictive maintenance.

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The first embodiment of the invention (the system **1-01**) and the second embodiment of the invention (the method) both use a plurality of IoT sensors. These IoT sensors can be categorized as listed below.

15 **I. Consumption Sensors**

- a. hand dryer watt meter: measures overall current consumption for toilet room **01**; server **12** sends out alert whenever current level indicates possible lack of electricity and/or a change in current consumption indicating damaged heating elements or a short circuit
- 20 b. paper towel sensor: measures balance level of paper towel in the dispenser; server **12** sends out an alert whenever a threshold (e.g., less than 10% remaining) has been reached indicating the paper towels need to be replenished or refilled
- c. soap dispenser sensor: single soap dispenser or a ganged soap dispenser; measures the level of soap in the soap tank reservoir; server **12** sends out an alert whenever a threshold (e.g., less than 10% remaining) has been reached indicating the soap dispenser needs to be replenished or refilled
- 25 d. toilet paper roll dispenser sensor: measures balance level of toilet paper roll in the dispenser; server **12** sends out an alert whenever a threshold (e.g., less than 10% remaining) has been reached indicating the toilet paper roll needs to be replenished or refilled
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- e. toilet room watt meter: measures overall current consumption and/or whether hand dryer is Active/Inactive; server 12 sends out alert whenever current level indicates hair dryer fault and/or a heating element that is inactive or faulty
- f. urinal flush sensor: indicates solenoid in on or off position and/or water flow volume; server 12 sends out an alert whenever a time threshold has been reach indicating the solenoid is stuck in the on or off position and/or whenever the water flow volume exceeds a threshold for a period of time; possibly used also an indicator of traffic and/or usage patterns
- g. water closet flush sensor: indicates solenoid in on or off position and/or water flow volume; server 12 sends out an alert whenever a time threshold has been reach indicating the solenoid is stuck in the on or off position and/or whenever the water flow volume exceeds a threshold for a period of time; possibly used also an indicator of traffic patterns; a water closet flush sensor can include an infrared sensor; water closet flush sensors can be used as an occupancy counter and/or an indicator that a user of the toilet room 01 is present in a water closet cubicle
- h. water tap sensor: indicates solenoid in on or off position and/or water flow volume; server 12 sends out an alert whenever a time threshold has been reach indicating the solenoid is stuck in the on or off position, whenever the tap is open but there is no water flow, and/or whenever the water flow volume exceeds a threshold for a period of time

II. Environmental Status Sensors

- a. ammonia sensor: measures presence of ammonia in the toilet room 01; server 12 sends out an alert whenever a threshold has been reached indicating an unsatisfactory ammonia smell level in the toilet room 01
- b. humidity sensor: measures humidity of the toilet room 01
- c. air quality sensor: measures air quality levels in the toilet room 01; server 12 sends out an alert whenever a threshold has been reached indicating air quality in the toilet room 01; air quality can be assessed for presence by the air quality sensor for LPG, carbon monoxide, smoke, and/or other dangerous gases
- d. mobile sensor 05: a sensor that is not permanently installed in the toilet room 01, such as sensor hand-carried by the maintenance staff; the mobile sensors 05 are

useful for smell, humidity, temperature, LPG, smoke, and carbon monoxide readings; a mobile sensor **05** could be integrated into a smart phone or a dedicated device; readings can then be uploaded to the server **12** and database **13** via a smart phone or tablet to the network **11** through a cellular network **11** or through a gateway **10** with a wireless transceiver; the mobile sensors **05** are convenient especially during a conversion period where not all toilet rooms **01** include the full array of the IoT sensors or where a particular sensor is too expensive or delicate for installation into all the toilet rooms **01**

- e. smell sensor: measures smells in the toilet room **01**; server **12** sends out an alert whenever a threshold has been reached indicating an unsatisfactory smell level in the toilet room **01**
- f. smoke sensor: measures smoke levels in the toilet room **01**; server **12** sends out an alert whenever a threshold has been reached indicating smoke in the toilet room **01**
- g. sound level sensor: measures sounds levels in the toilet room **01** in decibels; server **12** sends out an alert whenever a threshold has been reached indicating an abnormal sound level
- h. temperature sensor: measures ambient temperature of the toilet room **01**
- i. water leak sensor: detects an accumulation or leak of water in the toilet room **01**; server **12** sends out an alert whenever leak has been detected

III. Traffic Pattern Sensors

- a. people counter: detects the number of people entering and leaving the toilet
- b. RFID sensor: detects when the RFID card of a member of the staff is detected with the relevant cleaning staff, technician staff or supervisor ID information; information sent to server **12** for tracking, logging and analysis
- c. urinal flush sensor: sensor used to detect usage of urinal; this sensor is a dual use sensor as it is used both to indicate the water consumption from the urinal flushing and also as an indication of occupancy or traffic patterns in the toilet room **01**
- d. water closet flush sensor: sensor used to detect occupancy of water closet; this sensor is a dual use sensor as it is used both to indicate the water consumption from the water closet flushing and also as an indication of occupancy or traffic patterns in the toilet room **01**

A first embodiment of the invention is a toilet room management system for maintaining a plurality of toilet rooms **01** by a staff comprising: (a) a plurality of IoT sensors configured to create sensor data for calculation of a consumption status for a plurality of consumables, an environmental status for each toilet room **01**, and a traffic pattern for each toilet room **01**; (b) a gateway **10** configured to receive the sensor data from each of the IoT sensors; and (c) a server **12** in communication with the gateway **10** and at least one user interface **06** through a network **11**, wherein the server **12** includes a database **13**. The database **13** includes: (i) an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters; (ii) an IoT inventory for each toilet room **01**; (iii) a staff profile for each member of the staff; (iv) a time series archive of the sensor data for each of the plurality of toilet rooms **01**; (v) at least one consumable replenishment schedule; and (vi) at least one maintenance schedule with a plurality of task items. The server **12** is configured to: (i) store and collate the sensor data in the time series archive; (ii) generate a plurality of task items and a plurality of reports, wherein each task item includes a current task status; (iii) monitor in real time the IoT sensors and create a plurality of urgent maintenance alerts; (iv) recommend updates for the consumable replenishment schedule and the maintenance schedule; and (v) generate screen information for the user interfaces **06** to present the task items, the reports, and the urgent maintenance alerts; and receive data input from the staff.

A second embodiment of the invention is a method of toilet room management employing IoT sensors comprising the steps of: (a) connecting to a gateway **10** configured to receive sensor data from a plurality of IoT sensors, wherein the IoT sensors are configured to create sensor data; (b) providing a server **12** in communication with the gateway **10** and at least one user interface **06**, wherein the server **12** includes a database **13**; and (c) performing on the server **12** the steps of: (i) calculating a consumption status for a plurality of consumables, an environmental status for each toilet room **01**, and a traffic pattern for each toilet room **01**; (ii) storing and collating the sensor data in the time series archive; (iii) generating a plurality of task items and a plurality of reports, wherein each task item includes a current task

status; (iv) monitoring in real time the IoT sensors and create a plurality of urgent maintenance alerts; (v) recommending updates for the consumable replenishment schedule and the maintenance schedule; and (vi) generating screen information for the user interfaces **06** to present the task items, the reports, and the urgent maintenance alerts, and also to receive data input from the staff. The database **13** includes: (i) an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters; (ii) an IoT inventory for each toilet room **01**; (iii) a staff profile for each member of the staff; (iv) a time series archive of the sensor data for each of the plurality of toilet rooms **01**; (v) at least one consumable replenishment schedule; and (vi) at least one maintenance schedule with a plurality of task items.

Each IoT sensor can be in communication with the gateway **10** via at least one of a wireless transceiver and a wired link. Also communication between the IoT sensors, the gateway **10**, the server **12**, and the user interfaces **06** can be encrypted and at least one of the IoT sensors can be configured to receive at least one command from the server through the gateway.

The commands received by the at least one of the IoT sensors can be at least one of a flush command, a water flow command, an alert signal, and a configuration command. The flush command, for instance, can be sent by the server to the urinal flush sensor to flush the urinal and/or to the water closet flush sensor to flush the water closet. The water flow command can be sent to the water tap sensor to start, stop, and/or pulse water flow through the water tap. The alert signal can be used to flash an LED and/or sound an audible signal to help alert and direct a member of the staff to repair, replace, maintain, and/or refill an item in one of the toilet rooms **01**. The configuration command can be used to configure an IoT sensor with a level of specificity, a scheduled reporting frequency, and/or a sleep mode.

In addition, the gateway **10** can include at least one of: (a) a Wi-Fi Access Point to aggregate data packet transfer to and from the server **12**; (b) a local area network; and

(c) a NB-IoT or 3G SIM card based mobile communication network. The IoT sensors can also be conducted via a Message Queuing Telemetry Transport.

5 A Wi-Fi Access point is a wireless access point that allows a Wi-Fi device to connect to a wired network. It usually connects to a router (via a wired network) as a standalone device, but it can also be an integral component of the router itself.

NB-IoT refers to a low power WAN standard using a SIM to enable cellular devices and services. NB-IoT focuses specifically on indoor coverage, low cost, long battery
10 life, and high connection density. 3G is a widely available cell phone communication standard. Both NB-IoT or 3G can provide coverage for remote areas that do not have a wired telecommunications infrastructure.

Message Queuing Telemetry Transport) is an ISO standard publish-subscribe-based
15 messaging protocol. It works on top of the TCP/IP protocol. It is designed for connections with remote locations where a small code footprint is required or the network bandwidth is limited.

The consumption status can be calculated from the sensor data of at least one of a soap
20 dispenser sensor, a water tap sensor, a hand dryer watt meter, a toilet room watt meter, a toilet paper roll dispenser sensor, a paper towel sensor, a waste bin sensor, at least one urinal flush sensor, and at least one water closet flush sensor. The environmental status can be calculated from the sensor data of at least one of a temperature sensor, a humidity sensor, a sound level sensor, a smoke sensor, a smell sensor, a water leak
25 sensor, and an air quality sensor. The traffic pattern can be calculated from the sensor data of at least one of an RFID sensor, a people counter, at least one of the urinal flush sensors, and at least one of the water closet flush sensors. At least one smell sensor can be an ammonia sensor. Each urgent maintenance alert can be determined based upon at least one of the consumption status, the environmental status, the traffic pattern, and a
30 loss of communication between the server 12 and one of the IoT sensors.

Urgent maintenance alerts can be categorized by at least one of a water leak, an over-running faucet, a flushing failure, a soap dispenser refill indication, a paper towel refill indication, and a toilet paper roll refill indication. The flushing failure can be caused, for instance, by insufficient water pressure, insufficient water flow, air in the water
5 lines, and/or excessively high water pressure.

The server 12 can be further configured to employ Machine Learning or Artificial Intelligence (“AI”) programming to predict an emerging traffic trend and recommend changes for the consumable replenishment schedule and the maintenance schedule.
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Machine Learning or AI, sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals. Machine Learning or AI programs can mimic functions that humans associate with other human minds, such as learning and problem solving. Machine
15 Learning or AI can be used by the server 12 to progressively improve the quality of service (“QoS”) on specific cleaning tasks, and predict future changes in the need for consumables, maintenance, and repair. For instance, if the occupancy of a toilet room 01 increases, the system 1-01 may predict the increased need for soap, paper towels, and toilet paper roll for that toilet room 01. For use in larger facilities, such as airports,
20 Machine Learning or AI may also be used to connect to additional data outside the toilet room management system, such as upcoming passenger arrivals in an airport, to predict consumption and maintenance needs due to possible increase in usage.

The reports can include at least one of: (a) a consumption history including at least one
25 of an energy consumption, a water consumption, a paper towel consumption, a waste bin usage, a toilet paper roll consumption, and a soap consumption, wherein the consumption history is calculated from the sensor data in the time series archive; (b) a building management summary indicating a cleaning status and a maintenance status for the toilet rooms 01; (c) a manpower management summary indicating at least one of
30 a cleaning staff availability, a technician staff availability, a staff scheduling roster, a response time statistic, a staff attendance statistic, a staff efficiency statistic, and a plurality of staff substitution recommendations; (d) a performance index summary

indicating at least one of a downtime metric, an equipment fault history, an index of cleanliness, and a traffic history; (e) a system status including each IoT sensor and the gateway 10; and (f) an occupancy of each toilet room 01 determined from the sensor data collected from the urinal flush sensors and the water closet flush sensor of each toilet room 01. Entries in the equipment fault history can include at least one of a unit identifier, a location, a fault frequency, and a type of fault. The server 12 can be configured to recommend to a user an alternate toilet room 01 based on the occupancy of each toilet room 01. The reports can be presented in at least one dashboard screen in each user interface 06.

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Each user interface 06 can be configured to: (a) associate each task item with at least one member of the staff; (b) permit updating of the current task status of each task item; (c) record readings of at least one mobile sensor 05; and (d) record an adhoc cleaning. Each user interface 06 can be at least one of a portable tablet, a smart phone, a dedicated device, a laptop computer, or a desktop computer. Each staff profile can include a work location, a staff ID, a job designation, and a work schedule.

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While various aspects and embodiments have been disclosed herein, it will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit of the invention being indicated by the appended claims.

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CLAIMS

1. A toilet room management system employing IoT sensors comprising:
- (a) a plurality of IoT sensors configured to create sensor data for calculation of a
5 consumption status for a plurality of consumables, an environmental status for each toilet room, and a traffic pattern for each toilet room;
- (b) a gateway configured to receive the sensor data from each of the IoT sensors;
- (c) a server in communication with the gateway and at least one user interface through a network, wherein the server includes a database;
- 10 (d) wherein the database includes:
- (i) an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters;
- (ii) an IoT inventory for each toilet room;
- (iii) a staff profile for each member of the staff;
- 15 (iv) a time series archive of the sensor data for each of the plurality of toilet rooms;
- (v) at least one consumable replenishment schedule; and
- (vi) at least one maintenance schedule with a plurality of task items;
- (e) wherein the server is configured to:
- 20 (i) store and collate the sensor data in the time series archive;
- (ii) generate a plurality of task items and a plurality of reports, wherein each task item includes a current task status;
- (iii) monitor in real time the IoT sensors and create a plurality of urgent maintenance alerts;
- 25 (iv) recommend updates for the consumable replenishment schedule and the maintenance schedule; and
- (v) generate screen information for the user interfaces to present the task items, the reports, and the urgent maintenance alerts; and receive data input from the staff.

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2. The system of claim 1, wherein:
- (a) each IoT sensor is in communication with the gateway via at least one of a wireless transceiver and a wired link;
 - (b) communication between the IoT sensors, the gateway, the server, and the user
5 interfaces is encrypted; and
 - (c) at least one of the IoT sensors is configured to receive at least one command from the server through the gateway.
3. The system of claim 2, wherein the gateway includes at least one of:
- 10 (a) a Wi-Fi Access Point to aggregate data packet transfer to and from the server;
 - (b) a local area network; and
 - (c) a NB-IoT or 3G SIM card based mobile communication network.
4. The system of claim 2, wherein communication to and from the IoT sensors is
15 conducted via a Message Queuing Telemetry Transport.
5. The system of claim 1, wherein:
- (a) the consumption status is calculated from the sensor data of at least one of a soap dispenser sensor, a water tap sensor, a hand dryer watt meter, a toilet room
20 watt meter, a toilet paper roll dispenser sensor, a paper towel sensor, a waste bin sensor, at least one urinal flush sensor, and at least one water closet flush sensor;
 - (b) the environmental status is calculated from the sensor data of at least one of a temperature sensor, a humidity sensor, a sound level sensor, a smoke sensor, a
25 smell sensor, a water leak sensor, and an air quality sensor; and
 - (c) the traffic pattern is calculated from the sensor data of at least one of an RFID sensor, a people counter, at least one of the urinal flush sensors, and at least one of the water closet flush sensors.
- 30 6. The system of claim 5, wherein at least one smell sensor is an ammonia sensor.

7. The system of one of claim 5, wherein each urgent maintenance alert is determined based upon at least one of the consumption status, the environmental status, the traffic pattern, and a loss of communication between the server and one of the IoT sensors.
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8. The system of claim 1, wherein the urgent maintenance alerts are categorized by at least one of a water leak, an over-running faucet, a flushing failure, a soap dispenser refill indication, a paper towel refill indication, and a toilet paper roll refill indication.
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9. The system of one of claim 1, wherein the server is further configured to employ Machine Learning or AI programming to predict an emerging traffic trend and recommend changes for the consumable replenishment schedule and the maintenance schedule.
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10. The system of claim 1, wherein the reports includes at least one of:
- (a) a consumption history including at least one of an energy consumption, a water consumption, a paper towel consumption, a waste bin usage, a toilet paper roll consumption, and a soap consumption, wherein the consumption history is calculated from the sensor data in the time series archive;
 - 20 (b) a building management summary indicating a cleaning status and a maintenance status for the toilet rooms;
 - (c) a manpower management summary indicating at least one of a cleaning staff availability, a technician staff availability, a staff scheduling roster, a response time statistic, a staff attendance statistic, a staff efficiency statistic, and a
 - 25 plurality of staff substitution recommendations;
 - (d) a performance index summary indicating at least one of a downtime metric, an equipment fault history, an index of cleanliness, and a traffic history;
 - (e) a system status including each IoT sensor and the gateway; and
 - (f) an occupancy of each toilet room determined from the sensor data collected
 - 30 from the urinal flush sensors and the water closet flush sensor of each toilet room.

11. The system of claim 10, wherein entries in the equipment fault history includes at least one of a unit identifier, a location, a fault frequency, and a type of fault.
12. The system of claim 10, wherein the server is further configured to recommend to a user an alternate toilet room based on the occupancy of each toilet room.
13. The system of claim 10, wherein the reports are presented in at least one dashboard screen in each user interface.
- 10 14. The system of one of claim 1, wherein each user interface is configured to:
- (a) associate each task item with at least one member of the staff;
 - (b) permit updating of the current task status of each task item;
 - (c) record readings of at least one mobile sensor; and
 - (d) record an adhoc cleaning.
- 15 15. The system of one of claim 1, wherein each user interface is included on at least one of a portable tablet, a smart phone, a dedicated device, a laptop computer, and a desktop computer.
- 20 16. The system of claim 1, wherein each staff profile includes a work location, a staff ID, a job designation, and a work schedule.

17. A method of toilet room management employing IoT sensors comprising the steps of:
- (a) connecting to a gateway configured to receive sensor data from a plurality of IoT sensors, wherein the IoT sensors are configured to create sensor data;
 - 5 (b) providing a server in communication with the gateway and at least one user interface through a network, wherein the server includes a database and the database includes:
 - (i) an IoT description for each IoT sensor, wherein each IoT description includes a set of data attributes and a set of sensor parameters;
 - 10 (ii) an IoT inventory for each toilet room;
 - (iii) a staff profile for each member of the staff;
 - (iv) a time series archive of the sensor data for each of the plurality of toilet rooms;
 - (v) at least one consumable replenishment schedule; and
 - 15 (vi) at least one maintenance schedule with a plurality of task items; and
 - (c) performing on the server the steps of:
 - (i) calculating a consumption status for a plurality of consumables, an environmental status for each toilet room, and a traffic pattern for each toilet room;
 - 20 (ii) storing and collating the sensor data in the time series archive;
 - (iii) generating a plurality of task items and a plurality of reports, wherein each task item includes a current task status;
 - (iv) monitoring in real-time the IoT sensors and create a plurality of urgent maintenance alerts;
 - 25 (v) recommending updates for the consumable replenishment schedule and the maintenance schedule; and
 - (vi) generating screen information for the user interfaces to present the task items, the reports, and the urgent maintenance alerts, and also to receive data input from the staff.

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18. The method of claim 17, wherein:
- (a) each IoT sensor is in communication with the gateway via at least one of a wireless transceiver and a wired link;
 - (b) communication between the IoT sensors, the gateway, the server, and the user
5 interfaces is encrypted; and
 - (c) at least one of the IoT sensors is configured to receive at least one command from the server through the gateway.
19. The method of claim 18, wherein the gateway includes at least one of:
- 10 (a) a Wi-Fi Access Point to aggregate data packet transfer to and from the server;
 - (b) a local area network; and
 - (c) a NB-IoT or 3G SIM card based mobile communication network.
20. The method of claim 18, wherein communication to and from the IoT sensors is
15 conducted via a Message Queuing Telemetry Transport.
21. The method of claim 17, wherein:
- (a) the consumption status is calculated from the sensor data of at least one of a soap dispenser sensor, a water tap sensor, a hand dryer watt meter, a toilet room
20 watt meter, a toilet paper roll dispenser sensor, a paper towel sensor, a waste bin sensor, at least one urinal flush sensor, and at least one water closet flush sensor;
 - (b) the environmental status is calculated from the sensor data of at least one of a temperature sensor, a humidity sensor, a sound level sensor, a smoke sensor, a
25 smell sensor, a water leak sensor, and an air quality sensor; and
 - (c) the traffic pattern is calculated from the sensor data of at least one of an RFID sensor, a people counter, at least one of the urinal flush sensors, and at least one of the water closet flush sensors.
- 30 22. The method of claim 21, wherein at least one smell sensor is an ammonia sensor.

23. The method of one of claim 21, wherein each urgent maintenance alert is determined based upon at least one of the consumption status, the environmental status, the traffic pattern, and a loss of communication between the server and one of the IoT sensors.

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24. The method of claim 17, wherein the urgent maintenance alerts are categorized by at least one of a water leak, an over-running faucet, a flushing failure, a soap dispenser refill indication, a paper towel refill indication, and a toilet paper roll refill indication.

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25. The method of one of claim 17, wherein the server is further configured to perform the step of employing Machine Learning or AI programming to predict an emerging traffic trend and recommend changes for the consumable replenishment schedule and the maintenance schedule.

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26. The method of claim 17, wherein the reports includes at least one of:

(a) a consumption history including at least one of an energy consumption, a water consumption, a paper towel consumption, a waste bin usage, a toilet paper roll consumption, and a soap consumption, wherein the consumption history is calculated from the sensor data in the time series archive;

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(b) a building management summary indicating a cleaning status and a maintenance status for the toilet rooms;

(c) a manpower management summary indicating at least one of a cleaning staff availability, a technician staff availability, a staff scheduling roster, a response time statistic, a staff attendance statistic, a staff efficiency statistic, and a plurality of staff substitution recommendations;

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(d) a performance index summary indicating at least one of a downtime metric, an equipment fault history, an index of cleanliness, and a traffic history;

(e) a system status including each IoT sensor and the gateway; and

30 (f) an occupancy of each toilet room determined from the sensor data collected from the urinal flush sensors and the water closet flush sensor of each toilet room.

27. The method of claim 26, wherein entries in the equipment fault history includes at least one of a unit identifier, a location, a fault frequency, and a type of fault.
28. The method of claim 26, wherein the server is further configured to perform the
5 step of recommending to a user an alternate toilet room based on the occupancy of each toilet room.
29. The method of claim 26, wherein the reports are presented in at least one
10 dashboard screen in each user interface.
30. The method of one of claim 17, wherein each user interface is configured to:
- (a) associate each task item with at least one member of the staff;
 - (b) permit updating of the current task status of each task item;
 - (c) record readings of at least one mobile sensor; and
 - 15 (d) record an adhoc cleaning.
31. The method of one of claim 17, wherein each user interface is included on at least one of a portable tablet, a smart phone, a dedicated device, a laptop computer, and a desktop computer.
- 20 32. The method of claim 17, wherein each staff profile includes a work location, a staff ID, a job designation, and a work schedule.