System Requirements Specification (SyRS) document

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1. Introduction

1.1. System purpose

The system for Digital Health Inc.'s personal food log application is a necessary component of the project in order to handle and validate data within the application. The system's main purposes include verifying user, meal, photo, and report data by their unique IDs, and then storing them each into their respective database. This allows the system to interact with the user interface components of the application in an organized manner by quickly receiving and sending back requests from and to the user.

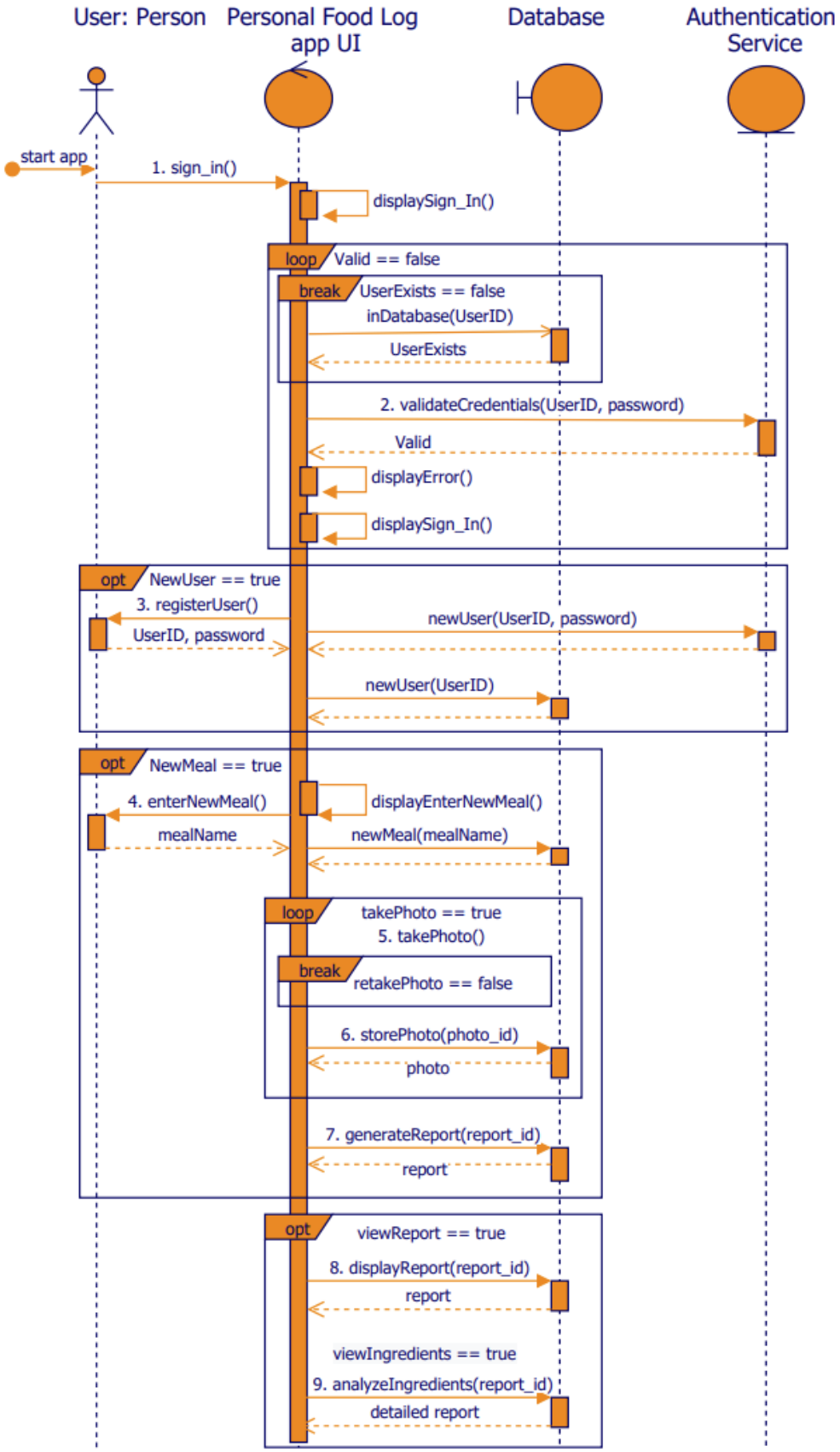
1.2. System scope

The system to be developed is a vision-based measurement system that will be deployed on both major smartphone operating systems which supports the application's purpose of allowing users to take photos of food and then be returned a detailed report regarding the ingredients within the photo and their respective calories.

In order to achieve the application's purpose, the system will be responsible for all data verification and validation within the application. The system shall ensure that the user is able to receive a report regarding the meal they have taken a photo of without experiencing any errors during that process. However, the system will not perform any intensive computations such as analyzing photos from the user using machine learning as the software shall be responsible for that. The system only serves to connect the front-end, back-end, and database components of the application while minimizing any potential errors.

By connecting the three aforementioned components of the application, the system allows users to trigger the application's software features correctly without errors such as having duplicate report IDs when multiple reports are generated. The system also helps to verify user credentials when logging into the application and stores them securely

1.3. System overview



1.3.1. System context

An end user interacts with the application through their phone by taking a picture of a food item using their camera and viewing the results on the screen of the phone. The user will navigate through the application to access various features and functions of the application based on the method provided by the device being used.

1.3.2. System functions

The application allows a user to take a photo of the food item using their phone camera and then prompt the system to analyze it to reveal the nutritional and caloric makeup of the food. The application will also allow the creation of multiple user profiles so that various family members can separately measure their energy intake. Lastly, the application will provide various statistics that help a user understand their eating patterns.

The application must provide results that have a minimum accuracy of 94.11%, as it was shown in a research proof-of-concept that this level of accuracy should be possible when detecting foods. However, it is likely that the system will only be able to recognize well-photographed and high-resolution images. The application will also require an active internet connection to provide reliable results.

1.3.3. User characteristics

- Application user - This is the primary user of the application who uses it to measure their caloric intake by taking photos of their food and having the application analyze them. This type of user cannot view the source code of the application nor can they modify it.
- Application maintainer - This person is employed by Digital Health Care Inc and they are responsible for ensuring that the application’s services work as expected. This type of user can view the source code of the application and modify it if required.

2. System requirements

2.1. Functional requirements

From the diagram in 1.3 System overview, we can generate the following functional requirements with respect to the system:

- The system shall verify if a user's UserID exists in the system's database when the user attempts to sign into their account.
- The system shall verify if a UserID exists when a user attempts to sign in by checking if the given UserID currently exists in the system's database.
- The system shall validate a user's credentials when attempting to sign in with given (UserID, password) and then return a response to the application that tells it if the credentials were valid or not.
- The system shall display either an error message or sign in message based on the validity response from the authentication service.
- The system shall add in a new (UserID, password) to the authentication service when a user is registering a new account.
- The system shall add in a new UserID to the database when a new user account is registered.
- The system shall store the mealName specified by the user into the database.
- The system shall store the photo taken by the user along with a generated photo_id into the database.
- The system shall overwrite the photo_id of the taken photo if the user chooses to retake the photo.
- The system shall return the photo to the user for viewing after it is stored into the database.
- The system shall generate a report after it successfully analyzes the meal and then store it along with a report_id into the database.
- The system shall return the report to the user for viewing after it is stored into the database.

- The system shall match the report_id to the specific report in the database that the user wishes to view and then will return that report to the user.

2.2. Usability requirements

Effectiveness:

- The system shall complete designated tasks with near perfect accuracy.
- The system's accuracy shall be continuously improved through user feedback.
- The system shall be protected by possible opportunities of user error by implementing solutions in the application's interface.

Efficiency:

- The system shall complete designated tasks with almost no delay.
- The system shall only display the most important information to a user.
- The system shall minimize the number of interactions between different system components to complete a given task.

Satisfaction:

- The system shall draw users in through its extensive AI image processing capabilities.

Intuitiveness:

- The system shall be easy to learn given its small number of different components.
- The system shall break down large, complex tasks into a collection of smaller, basic tasks.

Error tolerance:

- The system shall find opportunities to validate errors.
- The system's error messages will include opportunities to correct errors.

2.3. Performance requirements

Performance requirements will be separated under the different system operational modes that the application supports.

Default Mode:

- The system shall store items such as meals, photos, reports into the database in no more than 5 seconds when the load on server resources may not be more than 75%.
- The system shall remain active for at least 30 minutes when the load on server resources may not be more than 95% on average.
- The system’s average response time shall be no more than 10 seconds on average when generating a report for all active server load levels.
- The system’s average response time shall be no more than 5 seconds when displaying a report for all active server load levels.

Premium Mode:

- The system shall store items such as meals, photos, reports into the database in no more than 2 seconds where the load on server resources may not be more than 90%.
- The system shall remain active for at least 6 hours when the load on server resources may not be more than 95% on average.
- The system’s average response time shall be no more than 4 seconds when generating a report for all active server load levels.
- The system’s average response time shall be no more than 2 seconds on average when displaying a report for all active server load levels.

Manual Mode:

- There are no performance requirements during manual mode since there will be no connection with the server.

2.4. Interface requirements

2.4.1. External interface requirements

- The application shall be used by a mobile device with any of the following operating systems:
    - iOS
    - Android
- The system and its server shall be run by a computer with any of the following operating systems:
    - Windows
    - Linux
    - macOS
- The system and its server require any additional frameworks needed to interact with AWS.
- All data transferred between the server and individual mobile devices shall use the TCP/IP networking protocol.

2.4.2. Internal interface requirements

- The system database shall support AWS.
- The authentication service shall be compatible with the selected database above if an API is used.

2.5. System operations

Maintainability & reliability requirements:

- Mean downtime: 1 hour
- Maximum downtime: 24 hours
- Reaction time: 15 minutes
- Turnaround time: 45 minutes
- Mean time to repair: 45 minutes
- Maximum time to repair: 24 hours

- Mean time between maintenance actions: 60 minutes
- Operational ready rate: 90%
- Maintenance time per operating hour: 5 minutes

2.6. System modes and states

Default mode

In this operational mode, the system will operate normally for regular registered users with all of the default features mentioned above.

Premium mode

In this operational mode, the system will operate at a faster speed for premium registered users who are paying a monthly subscription to the application. Additional system features include locally storing data, more specific/detailed reports, and report customizability.

Manual mode

In the event of an unexpected server error, the system will operate in manual mode which means it will not be capable of image processing or storing any user/photo/report data to the server's database. However, premium users will be capable of storing the following data to their local devices. These data objects will be first in the queue for the system to process when the server is back online.

2.7. Physical characteristics

The system shall be installed in a server room that will contain multiple server racks in order to ensure expandability. Although the room will initially utilize a small portion of these servers, installing multiple server racks will reduce downtime and further constructions costs should the system later need more storage space. This room shall be continually cooled by air conditioning in addition to the cooling fans that will be present in the server racks themselves, to ensure there are no overheating issues that could lead to

system failure. The servers shall use high speed industrial-level solid state drives (SSDs) to ensure the fastest access speeds when users try to generate a report. However, hard disk drives (HDDs) can also be utilized as a cheaper but slower alternative to store less important data such as usage logs. To further increase access speeds for users, 10 gigabit ethernet connecting all the servers shall also be necessary. The room and/or the server racks shall also have to be lined with dampening materials such as dense industrial foam to reduce the possibility of vibrations damaging the HDDs should they be installed.

2.8. Environmental conditions

To ensure the highest level of longevity of the hardware, the system should be installed in a humid cool environment. This will not only lessen the workload of the air conditioning, but also reduce the conduction of static electricity that could potentially damage the SSDs installed in the server racks. Locations that have infrequent earthquakes would also be ideal, as opposed to countries that have recurrent earthquakes such as Japan, as the latter will likely shorten the life expectancy of HDDs.

2.9. Security requirements

The system shall ensure secure information access by utilizing a permission system with multi-factor authentication. Different people shall have varying levels of access; clients will only be able to send requests so their device may utilize information relevant to their current query to generate a report. They will not be able to access any information related to user data. Developers shall be allowed to access the food database but will not have permissions to make changes to it and will not be able to access user information. Support staff and senior developers, similarly to developers, shall not be able to access user information, but they will be able to make changes to the food database. Finally, administrative personnel shall have full permissions to the database, including the user database.

All staff shall have an account that will utilize both a password and a secondary device to authenticate them before the database can be read from or written to. As the information

that is stored will contain sensitive user information such as payment methods, it is important that not all staff have the same access to information, and all staff must be verified using multiple-factor verification to ensure the information is secure.

2.10. Information management requirements

Photos that users submit for report generation shall be uploaded and stored on Amazon Web Services, as required by Digital Health Inc.

The system shall receive information on new foods that are submitted for review, and once they have been reviewed and verified this information will be added to the database of foods. The system shall also store user information in the form of name, password, e-mail, and payment method that are linked to that specific account. However, to ensure safety for the users, sensitive information will be encrypted. Additionally, the system shall receive and store information on the number of users and their subscription types, number of reports generated, as well as basic information of when and by who a report was generated. This will give an accurate assessment of the usage of the application and thus its level of success.

It also may be useful to generate and store usage logs that will record information such as server uptime and downtime, cause of downtime, and change in database. Because this information is less frequently accessed than the statistics of users and reports, speed is less of a concern so they will be stored on HDDs. All data shall be archived onto HDDs for a cost-effective solution, and data shall be backed up in its corresponding storage option, with about 10% of drives used as backup drives.

2.11. Policy and regulation requirements

All full-time employees shall work a 40-hour week. Because the server must have technicians stationed 24/7 in case of an unexpected issue, a rotating shift of server technicians must be present.

The system shall have multilingual support, with initial release only having support for English but additional languages will be added in future releases. This will require hiring multiple translators to ensure the UI is grammatically correct in all languages.

2.12. System life cycle sustainment requirements

During the development phase, the system shall be thoroughly documented so that maintaining the software will be a much easier task in the future. Additionally, the system shall require support personnel to handle requests for foods to be added to the food database. This will require training, not only to have a fundamental understanding of the database, but also to understand the requirements for a food to sufficiently provide merit to the database. Finally, the server room shall have multiple spare storage drives on hand in addition to the backup drives that are already present. This will be a further failsafe, in case there is a major issue with multiple drives at once that causes data loss in both the main storage drive and its backup.

2.13. Packaging, handling, shipping, and transportation requirements

The system does not have major packing, handling, shipping, or transportation requirements. As the server that contains the food database and user information will be statically situated, it is unlikely that there will be issues with shipping the hardware that may cause difficulties with the assembly and initialization of the server.

3. Verification

3.1. Functional requirements

The application shall be installed and demonstrated for functionality on all of the following operating systems:

- iOS
- Android

The application shall go through a complete set of unit tests to assure code-related functionality and lack of logic or calculation bugs. The application shall go through a complete set of functional tests on each operating system environment to assure functionality and lack of environment related bugs. The application shall also be tested on multiple devices that use different versions of the operating systems. For iOS, the application will be tested on iOS 8 to iOS 14. For Android, the application shall be tested on Android 8.1 to 11.

The application server shall be compiled and executed on all of the following operating systems:

- Windows
- Linux
- macOS

The server will go through a complete set of unit tests on each operating system environment to assure lack of logic or environment related bugs. The server will also be functionally tested by connecting with applications undergoing functional tests on multiple phone operating system environments. These tests will assure functionality and lack of compatibility related bugs.

The system and its server shall be inspected for all required frameworks needed to interact with AWS. The code as well as the dependencies will be inspected in a team-wide code review process to make sure that all dependencies are installed and working before deploying the project. The system and the server will also be extensively tested

with various random inputs. If the system or the server needs any dependencies that have not been installed, the tests will crash and show where the missing dependencies are.

The communication between server and individual mobile devices shall be inspected to be sure that they use the TCP/IP networking protocol. The code as well as the network communications will be inspected in a team-wide code review process to make sure that proper networking protocols are used for security.

3.2. Usability requirements

Effectiveness

The system shall be both functionally and unit tested to ensure that tasks are done correctly. The AI system will receive a variation of different inputs and the resulting calculated outputs will be compared against the expected outputs for accuracy. The acceptance criteria for effectiveness is a 100% match between expected outputs and calculated outputs. The system will also be tested with various random inputs, both valid and invalid, to ensure that the system responds to user error correctly by detecting the error and displaying some error message. The acceptance criteria for effective error detection is a 100% match of times of invalid input and return of error having been detected.

Efficiency

The system shall be tested through both UI and an automated test suite to ensure lack of bottlenecks or latency within. Performance metrics such as the time taken for an action or the number of inter-system calls for an action will be measured and compared against predetermined standards for performance acceptance criteria for each of the actions. The acceptance criteria for efficiency is that measured performance metrics such as time taken for an action should be equal to or less than the predetermined standard 95% of the time. The output provided to the user after each action will also be analyzed for any unnecessary information.

Satisfaction

There will be a team of test users who will try out using the system before the product is released. The test users will be asked a series of questions each on their user experience and satisfaction with the system for a user experience survey. If there is any feedback, they will be taken into account and implemented as well. The acceptance criteria for user experience is 95% of the test users being satisfied with the system.

Intuitiveness

Some randomly selected users from the team of new test users will not be given any instructions regarding the system before or during they use the system. The time they take to navigate the application and complete certain tasks will be recorded and compared against the time taken for new users with the instructions to have performed the same actions. The acceptance criteria for intuitiveness is a 15% difference in time taken for actions in users without any instructions compared to the users with the instructions.

Error tolerance

The system will be tested with various samples of invalid inputs. The system will offer the opportunity to validate input each time before submission. Once the input has been corrected and submitted, the results will be compared against the expected output. The acceptance criteria for error tolerance is a 100% match from corrected output and expected output.

3.3 Performance requirements

Default mode

The system shall measure performance by measuring time taken to store items such as meals, photos and reports into the database while load testing the server for various percentages of resources used. The acceptance criteria for storage performance time is

less than or equals 5 seconds when the load on server resources is less than or equals 75%.

The system shall test endurance of the system by testing the server for various load percentages and measuring how long the system performs at a stable level. The acceptance criteria for endurance is equals or greater than 30 minutes when the load percentage is less than or equals 95%.

The system shall measure average response times when completing tasks such as generating a report or displaying a report at various server load percentages. The acceptance criteria for response time is less than or equals 10 seconds for generating a report and less than or equals 5 seconds for displaying a report when the load percentage is less than or equals 100%.

Premium mode

The system shall measure performance by measuring time taken to store items such as meals, photos and reports into the database while load testing the server for various percentages of resources used. The acceptance criteria for storage performance time is less than or equals 2 seconds when the load on server resources is less than or equals 90%.

The system shall test endurance of the system by testing the server for various load percentages and measuring how long the system performs at a stable level. The acceptance criteria for endurance is equals or greater than 6 hours when the load percentage is less than or equals 95%.

The system shall measure average response times when completing tasks such as generating a report or displaying a report at various server load percentages. The acceptance criteria for response time is less than or equals 4 seconds for generating a report and less than or equals 2 seconds for displaying a report when the load percentage is less than or equals 100%.

Manual mode

No server performance verification is needed for manual mode since there is no connection with the server.

3.4. Interface requirements

3.4.1. External interface requirements

The application shall be installed on all of the following operating systems. The system shall go through a complete set of unit and functional tests to demonstrate functionality.

- iOS (8 to 14)
- Android (8.1 to 11)

The application server shall be compiled on all of the following operating systems. The server will go through a complete set of unit and functional tests to assure lack of logic or environment related bugs. The various server environments shall be cross-tested with functional tests on various phone operating system environments to ensure lack of compatibility related bugs.

- Windows
- Linux
- macOS

The system and its server shall be inspected for all required frameworks needed to interact with AWS. The system shall go through a complete set of code reviews and random input-testing to ensure that all dependencies are installed and working.

The communication between server and individual mobile devices shall be inspected to be sure that they use the TCP/IP networking protocol. The system shall go through a complete set of code reviews and network communication inspections to ensure that proper networking protocols are used.

3.4.2. Internal interface requirements

The system database shall be inspected to be sure that it is compatible with AWS. Any code that interacts with the database shall go through a complete set of code reviews and the database structure shall be inspected to ensure compatibility.

The system authentication service shall be inspected to be sure that it is compatible with the database. The service shall go through a complete set of code reviews, unit tests and functional tests to ensure compatibility and functionality with the database.

3.5. System operations

The system shall measure maintainability and reliability by creating and enforcing a set of standards and schedule for things such as server repair, server maintenance, etc.

Server maintenance will be scheduled with one task per every hour, and the time needed to complete each task for maintenance will be measured. The acceptance criteria for any maintenance task is less than or equals five minutes each.

Server failure will be induced, and repair time will be measured in case of server failure. The server will be introduced with various inputs to induce all ranges of available events. Once the server fails, the time taken for the server team to access the server, and server team to repair the server will be measured. The acceptance criteria for the server team’s response is less than or equals 15 minutes, while the server repair time is less than or equals 45 minutes. In case of catastrophic failure only, the acceptance criteria for server repair time and server downtime is less than or equals 24 hours.

3.6. System modes and states

Default Mode

The system will be functionally and unit tested using a test user’s profile and default access level. The access control will also be tested functionally and unit tested by using

the default user's access to try to access functionalities available in default mode as well as only in premium mode such as locally storing data, more detailed level of reports, report customizability, etc. The acceptance criteria is for 100% of functionality available in default mode working as intended, as well as 0% of functionality available only in premium mode working.

Premium Mode

The system will be functionally and unit tested using a test user's profile and premium access level. The access control will also be tested functionally and unit tested by using the premium user's access to try to access functionalities available in default mode as well as only in premium mode such as locally storing data, more detailed level of reports, report customizability, etc. The acceptance criteria is for 100% of functionality available in default mode working as intended, as well as 100% of functionality available only in premium mode working.

Manual Mode

The system will be both functionally and unit tested using a test user's profile and premium access level. The access control will also be tested functionally and unit tested by using both default and premium user's access to try to access functionalities available in default manual mode as well as only in premium mode such as locally storing user/photo/report data. The acceptance criteria is for 100% of functionality available in manual mode working as intended for test user with default access level, as well as 0% of functionality available only in premium mode working for test user with default access level and 100% of functionality for test user with premium access level.

3.7. Physical characteristics

The physical location of the system's servers will be inspected during construction and annually after construction to be sure that they meet physical requirements such as:

- Servers are located in a dedicated server room.
- Server room contains multiple server racks for expandability.

- Server room is being continually cooled by air conditioning and cooling fans to ensure no overheating.
- All servers use industrial-level solid state drives (SSD) for report generation to ensure database access speed and hard disk drives (HDD) for storing data such as usage logs.
- All servers are connected by 10 gigabit ethernet to ensure access speed for users.
- Server room is lined with dampening material such as dense industrial foam to reduce vibrations.

3.8. Environmental conditions

The server room should be regularly inspected during and after construction to ensure that the environment is humid and cool. When constructing the site of the server room, the location will be analyzed for frequencies of past natural disaster occurrences to ensure that the location is not partial to events such as earthquakes.

3.9. Security requirements

The procedure for information access shall be inspected and updated regularly. A strict role-based access system shall be implemented for everyone with access to the system that prescribes only the strict necessary permission and database access to each user role or group, whether it is basic level user, premium level user, developer, senior developer, support staff or administrator. A zero-trust policy will be implemented by enforcing the use of Multi-Factor Authentication (MFA) for everyone with access to the system.

3.10. Information management requirements

The system will ensure that photos submitted by users are uploaded and stored on Amazon Web Services only through inspection of the code and testing.

The system will ensure that the information of food that has been submitted by users and reviewed through the system are added to the system database through inspection of the

code and testing. The system will also ensure that user and account information are added and stored in the system database, and that the database containing this information is encrypted securely.

Information such as statistics of system users, their subscription types and reports generated will also be added and stored in the system database. As well, usage logs on data such as server uptime and downtime, cause of downtime, changes in database will be stored on slower access system databases. These requirements will be validated for enforcement through inspection of the code prior to deployment as well as comprehensive testing.

3.11. Policy and regulation requirements

The working hours of the staff will strictly be enforced to encourage working no later than 40 hours per week at maximum. A shift schedule for server technicians will be established.

The system translations in various languages will all be inspected by experts for correctness in translation and grammar before being released to the public.

3.12. System life cycle sustainment requirements

A comprehensive functional and technical documentation standard shall be established during development and maintenance of the system. Training will be provided for maintenance staff to successfully upkeep the system regularly. The maintenance team will continue daily maintenance of the system after product deployment.

A list of spare and additional equipment for the server room will be created. The server room will be regularly inspected to assure continuous maintenance necessary.

3.13. Packaging, handling, shipping and transportation requirements

No verification is needed for packing, handling, shipping or transportation requirements of the system since the system does not have any major requirements in those areas.

4. Appendices

4.1. Acronyms and abbreviations

- VBM: Vision-based measurement
- AWS: Amazon Web Services

- API: Application Programming Interface
- TCP/IP: Transmission Control Protocol and the Internet Protocol
- SSD: Solid State Drive
- HDD: Hard Disk Drive