Verification and Validation Report: SyncMaster

Team 15, SyncMaster
Kyle D'Souza
Mitchell Hynes
Richard Fan
Akshit Gulia
Rafeed Iqbal

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1 Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

2 Symbols, Abbreviations and Acronyms

Refer to *Section 4: Naming Conventions and Terminology* of the Software Requirements Specification document SRS.pdf.

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3 Functional Requirements Evaluation

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4.1 Usability

Usability testing was conducted on the application prototype to validate humanity, look and feel, operational, and cultural requirements. Two users were given the following scenarios for the usability test, to simulate a typical use of the system:

Phase 1: Testing the contractor portal

You are a contractor hired by the City of Hamilton to perform work at a station. You arrive and scan the QR code at the station to authenticate your presence and explain the work you will perform. We will ask you to perform a variety of tasks to assess their discoverability and usability. We welcome you explaining your thought process as you navigate through the screens.

- You have scanned the QR code. Please follow the initial steps for the health and safety acknowledgements. Did the experience of viewing the acknowledgements screen feel easy and intuitive? Did you encounter any errors? After the acknowledgements, are you able to find the station documents?
- Are you able to find and fill out the instructions for the purpose of your visit?

Phase 2: Testing the admin portal

You are a Facility Manager who has an account with admin permissions. You sign into the application and would like to perform some routine tasks during the day.

- You would like to navigate to the station documents and add a site specific document for station HC057. Please attempt to do so. Were you frustrated trying to find where this was located?

- Please locate the site wide documents which would be displayed for all stations.
- Please locate and view the site visit logs.

2 Users were then directed to fill out the Usability Survey identified in the VnV Plan.
User 1: Man between the ages of 60 - 65, no prior experience with the system. User is comfortable using a smartphone and laptop.
User 2: Woman between ages of 60 - 65, no prior experience with the system. User is comfortable using a smartphone and laptop. Through these actions, the following results were observed:

Test. ID	**User**	**Result**
TC-EU-1	User 1	User successfully understood the distinction between the contractor and admin user. User experienced minor confusion what should be entered in the work order field, due to no real work order in scenario. User succesfully navigated core features of contractor and admin portal without issue. Test passed.
TC-EU-1	User 2	User successfully navigated to contractor portal. Minor difficulties understanding distinction of site wide and site and site specific documentation on the admin portal, emphasizing the emportance of user documentation in requirement MS-SUP-1. Confusion did not hinder accessing all features of admin portal. Test passed.
TC-EU-2	User 1	As an admin user, the tester was able to add a site wide document but did not receive a warning before deleting file thus identifying a bug in the system to be patched for rev1. Test failed.
TC-EU-2	User 2	As an admin user, the tester was able to add a site wide document but did not receive a warning before deleting file thus identifying a bug in the system to be patched for rev1, same as issue identified for User 1. Test failed.

TC-LR-1	User 1	User successfully discovered the documentation page. Did not have issues with selecting documents and rated their confidence as an 8. Test passed.
TC-LR-1	User 2	User successfully discovered the documentation page. Experienced minor confusion that documents are downloaded and not viewed in the application, but successfully opened the document. User gave their confidence a rating of 7. Test passed.
TC-LR-2	User 1	*No onboarding documentation yet, user documentation to be taught on Mar 14*
TC-LR-2	User 2	*No onboarding documentation yet, user documentation to be taught on Mar 14*
TC-UP-1	User 1	User did not report anything offensive or political through all pages of the system. Test passed.
TC-UP-1	User 2	User did not report anything offensive or political through all pages of the system. Test passed.
TC-UP-2	User 1	User did not encounter any system errors during use. Test passed.
TC-UP-2	User 2	User did not encounter any system errors during use. Test passed.
TC-AS-1	User 1	The user reported that accessibility of the application felt similar to the City of Hamilton's main website when asked to compare the two. They rated their accessibility features to be comparable with a rating of 9 out of 10. Test passed.
TC-AS-1	User 2	The user reported that the accessibility of the application felt similar to the City of Hamilton's main website when asked to compare the two. They rated the accessibility features of the application to be comparable with a rating of 8 out of 10. Test passed.

TC-LF-1	User 1	User reported that the colour palette of the application did not cause them any issues and it was quite simple. They appreciated that the main colours are white and blue and that the application did not have many distractions. Rated as a 10 out of 10. Test passed.
TC-LF-1	User 2	User reported that the colour palette of the application did not cause them any issues. Reported that some of the text on the Admin site visit logs was small and would be difficult to read without their glasses. Rated as an 8 out of 10 overall. Test passed.
TC-LF-2	User 1	User was able to repeat the actions asked of them at the beginning of this section on an iPhone 8 and Samsung Galaxy A13 for the contractor portal. User was able to use a Google Chrome and Microsoft Edge Browser on a Windows 10 operating system. Test passed.
TC-LF-2	User 2	User was able to repeat the actions asked of them at the beginning of this section on an iPhone 13 and Samsung Galaxy A13 for the contractor portal. User was able to use a Google Chrome and Microsoft Edge Browser on a Windows 10 operating system. Test passed.
TC-CR-1	User 1	User did not feel the application violated any of the corporate pillars. Test passed.
TC-CR-1	User 2	User did not feel the application violated any of the corporate pillars. Test passed.
TC-OE-1	User 1	User was able to access the application from their homes without issue. Test passed.
TC-OE-1	User 2	User was able to access the application from their homes without issue. Test passed.
TC-OE-2	User 1	User was successfully able to navigate the menus freely and reported a similar experience on both iOS and Android operating systems. Test passed.

TC-OE-2	User 2	User reported feeling a similar experience across applications. Noted they preferred the experience on iPhone over Android because they are more familiar with the iOS interface than an Android interface. Test passed.

Table 1: Usability Test Cases

Most of the usability tests were successful, a promising sign for the rev1 prototype. These initial tests did reveal some overlap in test cases and missing survey questions which will be used to refine the Usability Study further before it will be submitted in the Extras folder.

4.2 Performance

4.3 Maintainability and Support

Test. ID	**Input**	**Expected Output**	**Result**
TC-MS-4	-	There is 95% line coverage and 90% branch coverage on our code	Pass, this is being checked in GitHub actions
TC-MS-5	-	All functional requirements have a corresponding unit test	Pass
TC-MS-6	-	Contribution guidelines and maintainer documentation of system approved by the City of Hamilton	Fail, not yet approved
TC-MS-7	-	User manual exists and has been approved by the City of Hamilton	Fail, not yet created
TC-MS-8	-	OAS3 compliant documentation has been provided for all API's	Fail, not yet created
TC-MS-9	-	Internal abstractions (classes and functions) in the system have documentation associated with them	Pass, linter checks this
TC-MS-10	-	Documentation for deployment of the system exists	Fail, not yet created

Table 2: Maintainability and Support Test Cases

4.4 etc.

5 Comparison to Existing Implementation

This section will not be appropriate for every project.

6 Unit Testing

Note: Unit tests all use moto to mock AWS services.

6.1 Database Interaction Module Unit Tests

Test. ID	Description	Result
UT-DB1	Use the DBTable.put method to create an item, and check that it exists in the database afterwards	Pass
UT-DB2	Use the DBTable.put method with a failing precondition, and check that a ConditionCheckFailed is raised, and the item is not created	Pass
UT-DB3	Use the DBTable.put method with a permission error from AWS, and check that a PermissionException is raised, and the item is not created	Pass
UT-DB4	Use the DBTable.put method with an arbitrary error from AWS, and check that a ExternalServiceException is raised, and the item is not created	Pass
UT-DB5	Use the DBTable.get method to get a pre-existing item	Pass
UT-DB6	Use the DBTable.get method to get an item which does not exist, and check that a ResourceNotFound is raised	Pass
UT-DB7	Use the DBTable.get method with an arbitrary error from AWS, and check that a ExternalServiceException is raised	Pass
UT-DB8	Use the DBTable.delete method on a pre-existing item, and check that the item is no longer in the database	Pass

UT-DB9	Use the DBTable.delete method with a failing precondition, and check that a ConditionCheckFailed is raised, and the item is not deleted	Pass
UT-DB10	Use the DBTable.delete method with a permission error from AWS, and check that a PermissionException is raised, and the item is not deleted	Pass
UT-DB11	Use the DBTable.delete method with an arbitrary error from AWS, and check that a ExternalServiceException is raised, and the item is not deleted	Pass
UT-DB12	Use the DBTable.update method to update an item adding new attributes, and modifying existing ones, and check that these changes are reflected in the database	Pass
UT-DB13	Use the DBTable.update method to update an item removing some attributes and check that these changes are reflected in the database	Pass
UT-DB14	Use the DBTable.update method with a failing precondition, and check that a ConditionCheckFailed is raised, and the item is not updated	Pass
UT-DB15	Use the DBTable.update method with a permission error from AWS, and check that a PermissionException is raised, and the item is not updated	Pass
UT-DB16	Use the DBTable.update method with an arbitrary error from AWS, and check that a ExternalServiceException is raised, and the item is not updated	Pass
UT-DB17	Use the DBTable.query method, and ensure the returned items all match the query criterion	Pass
UT-DB18	Use the DBTable.query method, under a different GSI, and ensure the returned items all match the query criterion	Pass
UT-DB19	Use the DBTable.query method, with a reversed query direction, and ensure the returned items all match the query criterion	Pass
UT-DB20	Use the DBTable.query method, with using the start_key of an existing db item, to determine where to start the query from, and ensure the returned items all match the query criterion	Pass

UT-DB21	Use the DBTable.query method, using a filter expression alongside a key condition, and ensure the returned items all match the query criterion	Pass
UT-DB22	Use the DBTable.query method, with an invalid key condition, and ensure that a ConditionValidationError is raised	Pass
UT-DB23	Use the DBTable.query method with an arbitrary error from AWS, and check that a ExternalServiceException is raised	Pass

Table 3: Unit Test Cases for Database Interaction Module

6.2 File Storage Interaction Module Unit Tests

Test. ID	**Description**	**Result**
UT-FS1	Use the S3Bucket.create_upload_url method to create an upload url, upload some content to the url, and check that the content exists in the S3 bucket	Pass
UT-FS2	Use the S3Bucket.create_upload_url method with a S3Bucket object that does not have write permissions, and check that a PermissionException gets raised	Pass
UT-FS3	Use the S3Bucket.create_get_url method for a pre-existing file in S3, and check that the file content can be accessed through the url, and check that a PermissionException gets raised	Pass
UT-FS4	Use the S3Bucket.delete method on a pre-existing file in S3, and check that the file no longer exists	Pass
UT-FS5	Use the S3Bucket.delete method on a pre-existing file in S3, with an ETag mismatch, and check that a ResourceNotFound is raised	Pass
UT-FS6	Use the S3Bucket.delete method with a permission error, and check that a PermissionException is raised	Pass
UT-FS7	Use the S3Bucket.delete method with an arbitrary error from AWS, and check that a ExternalServiceException is raised	Pass

Table 4: Unit Test Cases for File Storage Interaction Module

6.3 Location Verification Module Unit Tests

Test. ID	Description	Result
UT-LV1	Use the verify_location method to verify a coordinate within a defined radius, and ensure the return value is True	Pass
UT-LV2	Use the verify_location method to verify a coordinate outside a defined radius, and ensure the return value is False	Pass
UT-LV3	Use the verify_location method to verify a coordinate just on the boundary of a defined radius, and ensure the return value is True	Pass

Table 5: Unit Test Cases for Location Verification Module

6.4 User Authentication Module Unit Tests

Test. ID	Description	Result
UT-UA1	Attempt to authenticate with a pre-existing user, and ensure that a token is successfully generated	Pass
UT-UA2	Attempt to authenticate with an invalid location, and ensure that an UnauthorizedException is raised	Pass
UT-UA3	Attempt to authenticate with an initial one-time password, and ensure that an ForceChangePasswordException is raised	Pass
UT-UA4	Attempt to authenticate with the wrong password, and ensure that an UnauthorizedException is raised	Pass
UT-UA5	Attempt to authenticate with a user that does not exist, and ensure that a ResourceNotFound is raised	Pass

UT-UA6	Attempt to authenticate with an arbitrary error from AWS, and ensure that a ExternalServiceException is raised	Pass
UT-UA7	Attempt to signout a user, with a valid access token, and ensure that the token is successfully invalidated	Pass
UT-UA8	Attempt to signout a user, with an invalid access token, and ensure that a BadRequestException is raised	Pass
UT-UA9	Attempt to signout a user, with an arbitrary error from AWS, and ensure that a ExternalServiceException is raised	Pass

Table 6: Unit Test Cases for User Authentication Module

6.5 User Management Module Unit Tests

Test. ID	**Description**	**Result**
UT-UM1	Create an admin, employee, and contractor account, using admin credentials	Pass
UT-UM2	Create a user, using admin credentials, where there is already another user using the same email, and check that a ConflictException is raised	Pass
UT-UM3	Create a user, using employee and contractor credentials, and ensure an UnauthorizedException is raised	Pass
UT-UM4	Create a user, with an arbitrary error occuring from AWS, and check that an ExternalServiceException is raised	Pass
UT-UM5	Get the details of an existing user, using admin and employee credentials	Pass
UT-UM6	Get the details of a user that does not exist, using admin and employee credentials, and ensure a ResourceNotFound is raised	Pass
UT-UM7	Use contractor credentials to get the details of their own user	Pass
UT-UM8	Use contractor credentials to get the details of another user, and ensure an UnauthorizedException is raised	Pass

UT-UM9	Get the details of a user, with an arbitrary error occuring from AWS, and check that an ExternalServiceException is raised	Pass
UT-UM10	Update a user, using admin credentials	Pass
UT-UM11	Update a user, using admin credentials, where the user to update does not exist, and check that a ResourceNotFound is raised	Pass
UT-UM12	Update a user, using employee and contractor credentials, and ensure an UnauthorizedException is raised	Pass
UT-UM13	Update a user, with an arbitrary error occuring from AWS, and check that an ExternalServiceException is raised	Pass
UT-UM14	Delete a user, using admin credentials	Pass
UT-UM15	Delete a user, using admin credentials, where the user to delete does not exist, and check that a ResourceNotFound is raised	Pass
UT-UM16	Delete a user, using employee and contractor credentials, and ensure an UnauthorizedException is raised	Pass
UT-UM17	Delete a user, with an arbitrary error occuring from AWS, and check that an ExternalServiceException is raised	Pass

Table 7: Unit Test Cases for User Management Module

6.6 Logging Module Unit Tests

Test. ID	**Description**	**Result**
UT-LG1	Create a site visit log, and ensure it gets added to the database	Pass
UT-LG2	Create a site visit log, with the same site id, user id, and entry time as an existing log, and ensure a ResourceConflict is raised	Pass
UT-LG3	Add an exit time to an existing log with no logged exit time, and ensure the change is reflected in the database	Pass

UT-LG4	Add an exit time to an existing log with no logged exit time, but an entry time prior to the exit time we are attempting to add, and ensure a TimeConsistencyException is raised	Pass
UT-LG5	Add an exit time to an existing log with a logged exit time, and ensure an ExitTimeConflict is raised	Pass
UT-LG6	Add an exit time, where there are no existing logs for the user at the given site, and ensure an ResourceNotFound is raised	Pass
UT-LG7	Get a list of all site visit logs, using admin and employee credentials	Pass
UT-LG8	Get a list of all site visit logs, using contractor credentials, and ensure that an UnauthorizedException is raised	Pass
UT-LG9	Get a list of all site visit logs using filters to only include logs modified between two given dates, and ensure that logs are correctly filtered	Pass
UT-LG10	Get a list of all site visit logs using a database start_key to start the listing from a certain log, and ensure that logs start from the correct location	Pass

Table 8: Unit Test Cases for Logging Module

6.7 Document Management Module Unit Tests

Test. ID	**Description**	**Result**
UT-DM1	Create a document, and ensure it gets added to the database with the correct information	Pass
UT-DM2	Create a document with the name parent folder and document names as an existing document and check that a ResourceConflict is raised	Pass
UT-DM3	Get a single document for a particular site id and parent folder	Pass
UT-DM4	Get a list of documents including both files and folders for a particular site id and parent folder	Pass

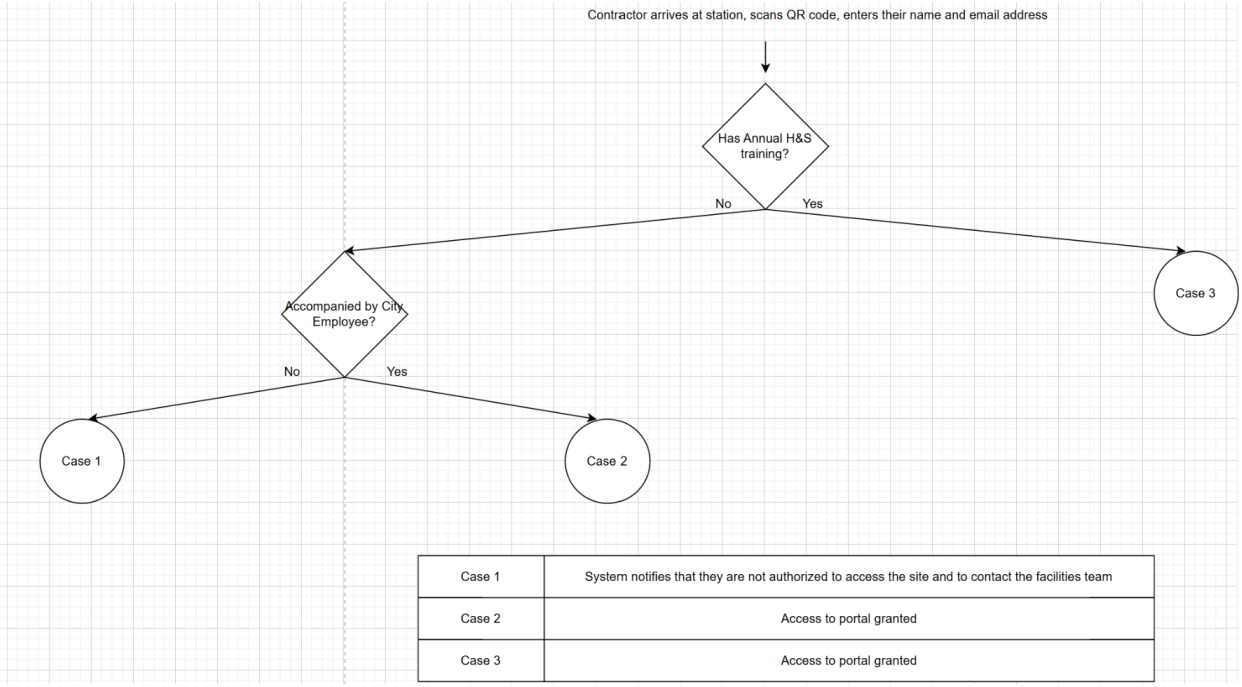
UT-DM5	Get a list of documents for a site id and folder that has no documents and ensure that an empty list is returned	Pass
UT-DM6	Generate a presigned url that is used to upload a binary file to Amazon S3 give a particular S3 key	Pass
UT-DM7	Delete an existing file for a given site id and parent folder given that the file exists	Pass
UT-DM8	Delete a document of type folder that has with documents inside for a given site id and parent folder and ensure that both the folder and its contents are recursively deleted	Pass

Table 9: Unit Test Cases for Logging Module

7 Changes Due to Testing

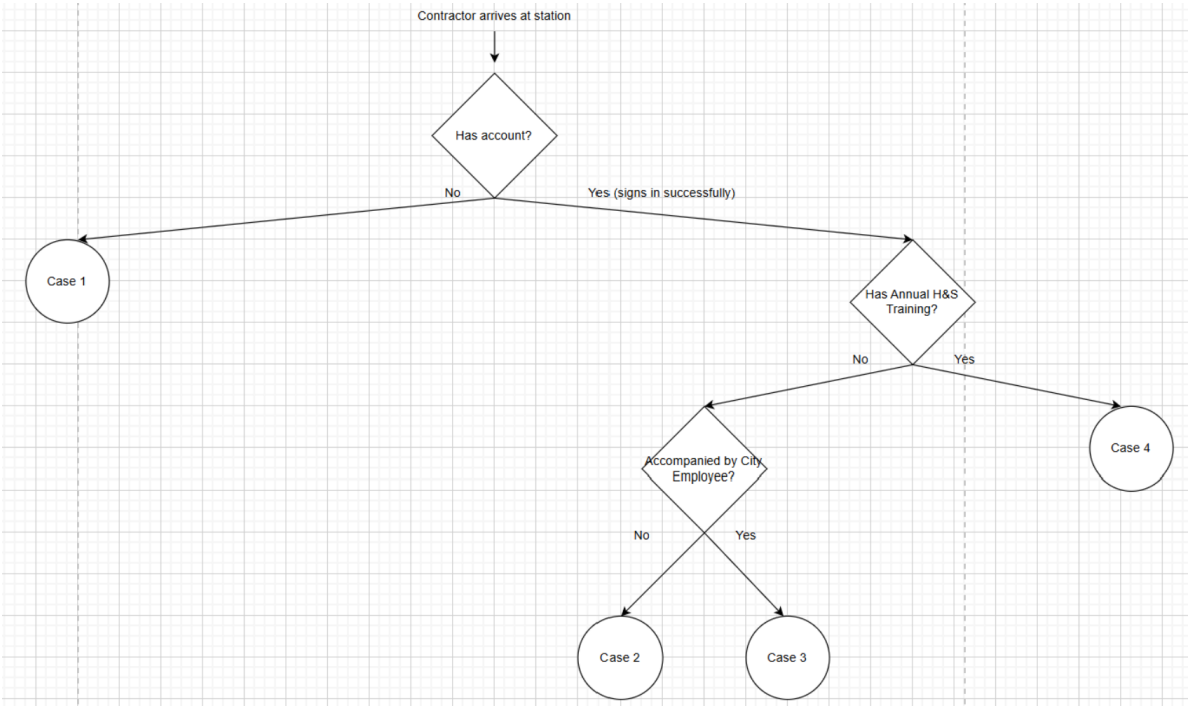
The scope of the project has evolved since the original version of the requirements were written. In meetings with the City where we demonstrated each revision of the prototype, new requirements emerged which were not conceived of in the original drafts. One example was the discussion surrounding a visitor account. When imagining use cases, it was discovered that a likely scenario that would emerge would be new contractors that need access to the portal but are not yet registered in the system. In the interest of ensuring work can still be completed, it was planned to have a visitor account that would enable contractors to access the system without any administrative overhead to create their account first. However, after creating a design, the team and the stakeholder realized this would allow any member of the public who scans a station QR code full access into the contractor portal and not merely legitimate contractors. This then led to the removal of this requirement. The scenarios are outlined in the following flow charts.

Prioritizing ease of access to the application with a visitor account:



Case 1	System notifies that they are not authorized to access the site and to contact the facilities team
Case 2	Access to portal granted
Case 3	Access to portal granted

Prioritizing security of the application by requiring a contractor account first be verified:



Case 1	Contractor is prompted to the account request screen. Unable to access portal until request is approved and they receive their sign-in instructions
Case 2	Contractor notified they are not authorized to access site and told to contact their facilities manager
Case 3	Contractor enters information of employee they are with and access to portal granted
Case 4	Access to portal granted

8 Automated Testing

N/A, the only automated testing we have is the unit tests.

9 Trace to Requirements

Req. ID	**Test ID's**
FR1	TC-FR1, TC-FR2, UT-DM1
FR3	TC-FR3, UT-UM3
FR4	TC-FR4, UT-LG7
FR5	TC-FR5, UT-UA2
FR6	TC-FR6, UT-DM1
FR7	TC-FR8, UT-DM4, UT-DM6
FR8	TC-FR7
FR9	TC-FR9
LF-AP1	TC-LF-1
LF-ST1	TC-LF-2
UH-EU1	TC-EU1
UH-EU2	TC-EU2
UH-LR1	TC-LR1
UH-LR2	TC-LR2
UH-UP1	TC-UP1
UH-UP2	TC-UP2
UH-AS1	TC-AS1
PR-SL1	TC-PR-1
PR-SL3	TC-PR-2
PR-SC1	TC-PR-3
PR-SC2	TC-PR-4
PR-PA1	TC-PR-5
PR-RFT1	TC-PR-7
PR-CR2	TC-PR-10
PR-SE1	TC-PR-11
OE-PE1	TC-OE-1
OE-WE1	TC-OE-2
OE-WE2	TC-OE-2

OE-REL1	TC-OE-4
OE-REL2	TC-OE-4
OE-REL3	TC-OE-4
OE-REL4	TC-OE-4
MS-MTN4	TC-MS-4
MS-MTN5	TC-MS-5
MS-MTN6	TC-MS-6
MS-SUP1	TC-MS-7
MS-SUP2	TC-MS-8
MS-SUP3	TC-MS-9
MS-SUP4	TC-MS-10
MS-ADP1	TC-LF-2
MS-ADP2	TC-LF-2
MS-ADP3	TC-LF-2
SR-AR1	TC-SS-1
SR-AR2	TC-SS-1
SR-AR3	TC-SS-1
SR-AR4	TC-SS-2
SR-IR1	TC-SS-2
SR-IR3	TC-SS-4
SR-PR1	TC-SS-5
SR-AU1	TC-SS-6
SR-IMR1	TC-SS-7
SR-S1	TC-SS-8
CR-CR1	TC-CR-1

Table 10: Requirements to Test Case Traceability Matrix

10 Trace to Modules

Note: * indicates that any test prefixed with the test case ID, covers the given module

Module	**Test ID's**
Database Interaction	UT-DB*

Logging	UT-LG*
File Storage	UT-FS*
Location Verification	UT-LV*
User Management	UT-UM*
User Authentication	UT-AU*
Document Management	UT-DM*

Table 11: Module to Test Case Traceability Matrix

11 Code Coverage Metrics

The unit testing achieves 95% line coverage and 90% branch coverage. This is checked by our GitHub Actions on every pull request.

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Reflection.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?

   Our team did a reasonable job at allocating work based on everyones different skill sets. Team members with more experience in developing backend tools were responsible for the testing on those technologies, whereas team members more familiar with the frontend and business logic worked on testing those functionalities.

2. What pain points did you experience during this deliverable, and how did you resolve them?

   One pain point we experienced was some complications fully implementing some of the more complex requirements and API integrations. This made it more difficult to test some aspects of the project and gave a tighter time frame. To resolve this, we used the Github issues to track progress on various components of the application and maintained regular communication to ensure we could be as prepared as possible for team meetings, meetings with the school, and meetings with the stakeholder.

3. Which parts of this document stemmed from speaking to your client(s)

or a proxy (e.g. your peers)? Which ones were not, and why?

The parts of the document in sections 3 and 4 (functional and non-functional requirements) generally stemmed from conversation with our stakeholder. Those parts of the document are directly intended to ensure that the requirements gathered throughout the project are satisfied. Our stakeholder is relying on our knowledge for the actual implementation, so the specific unit tests and other technical decisions regarding the modules themselves were a decision made by our team.

4. In what ways was the Verification and Validation (VnV) Plan different from the activities that were actually conducted for VnV? If there were differences, what changes required the modification in the plan? Why did these changes occur? Would you be able to anticipate these changes in future projects? If there weren't any differences, how was your team able to clearly predict a feasible amount of effort and the right tasks needed to build the evidence that demonstrates the required quality? (It is expected that most teams will have had to deviate from their original VnV Plan.)

   There were some changes to the number of tests performed, these are reflected in the VnV Plan with strikeouts and red text to make clear which changes were made to the original plan. In general, for industry projects such as these, there is always going to be some unanticipated requirements or challenges not originally envisioned until you get into the depths of an implementation which then requires you to reevaluate either the requirements or your initial design. This was an expected challenge and we did our best to minimize the occurences, and in general there were not an enormous number of deviations.