A Critical Analysis of the Project Development

APP : Combine Voucher System Among Multiple Irish Stores

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1 OVERVIEW OF APPLICATION

1.1 HIGH-LEVEL FUNCTIONALITY

App based rewards / points / vouchers scheme for customers of national and/or local stores.

- Customer registers using Android (or web-page login);
- Customers details are saved in central database;
- Customer enters a new store and scans QR code to sign-up (or web-page);
- Customer receives all vouchers via app – mailings, points, money-off, mailings, event vouchers, etc.;
- Customer can login with Facebook;
- Customer perhaps also receives proximity vouchers

1.2 APP FLOW – NEW USER (START TO END)

This flow covers a new user. The detailed start-to-end flow covers the user experience from when he/she starts the app to leave/closing it. A new user has some of the same views as an existing user :

- Home / Welcome

Once registered, the following are available :

- Store Listing : Add / Use | Store Status [store_name] | Bar-code / QR-code | Cancel Registration

However, he/she also has views restricted to new users only :

- Terms & Conditions | Register : Contact Details | Register : Login Details

1.2.1 MOCK-UP : START-TO-END FLOW

1.2.2 ACTUAL : START-TO-END FLOW

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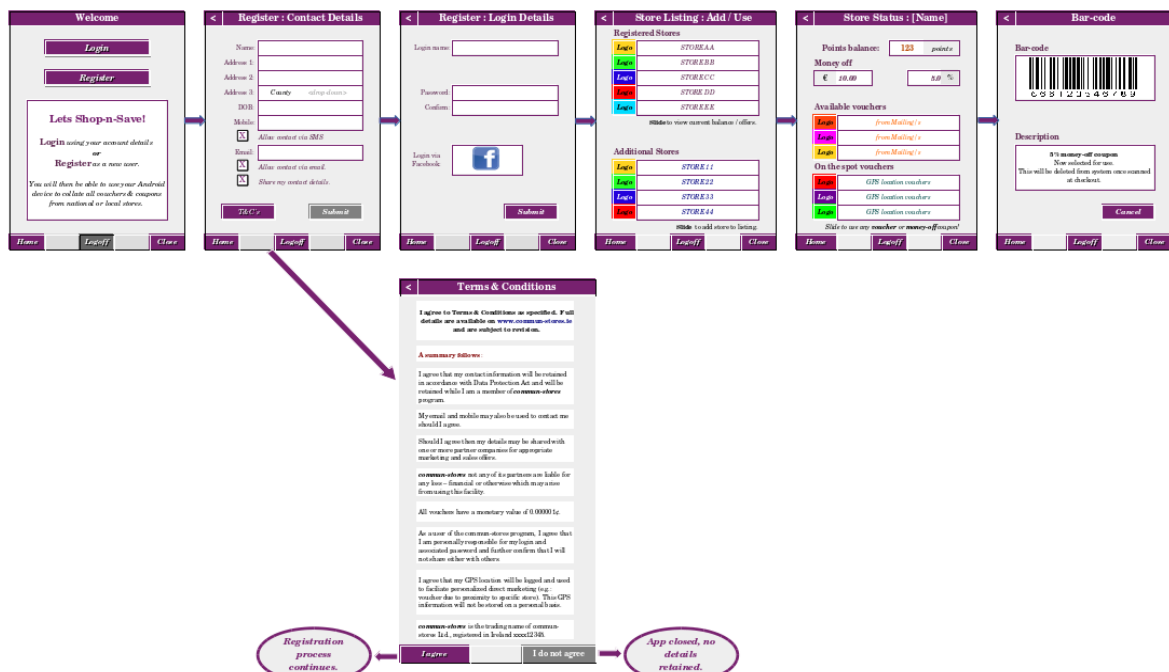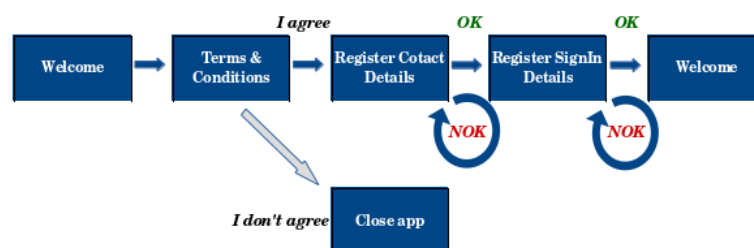
1.3   APP FLOW – EXISTING USER (START TO END)

This flow covers;; an existing user. The detailed start-to-end flow covers the user experience from when he/she starts the app to leave/closing it. An existing user has some of the same views as a new user :

• Home / Welcome

Once signed in the following are available :

• Store Listing : Add / Use | Store Status [store_name] | Bar-code / QR-code | Cancel Registration

However, he/she also has views restricted to existing users only :

• Login

1.3.1   MOCK-UP : START-TO-END FLOW
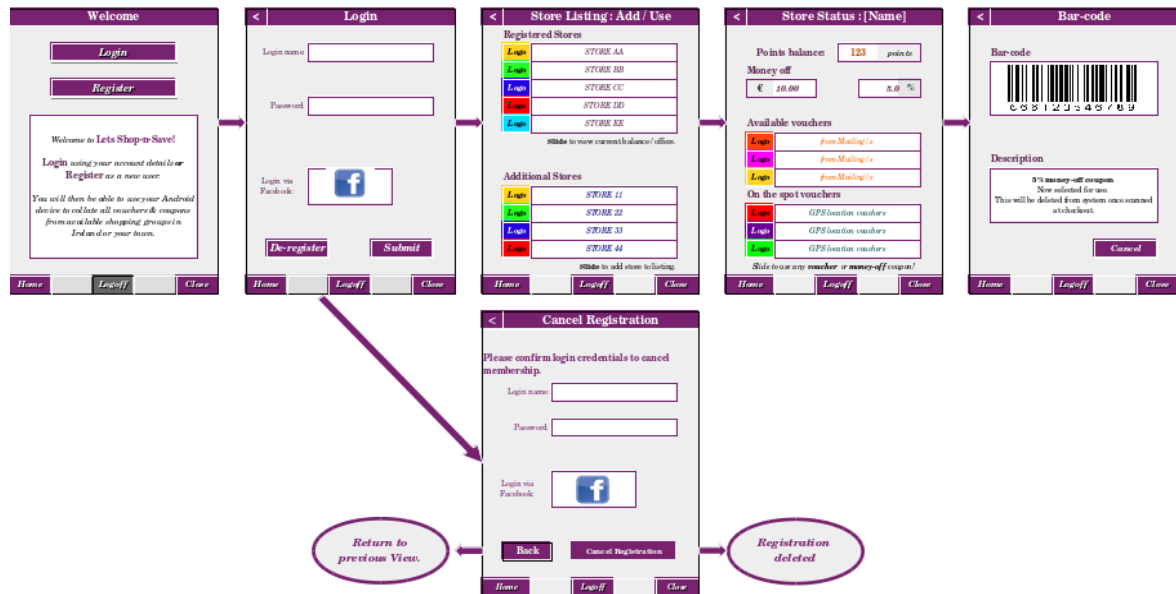
1.3.2   ACTUAL : START-TO-END FLOW

1.4   APP FILE STRUCTURE – ANDROID STUDIO
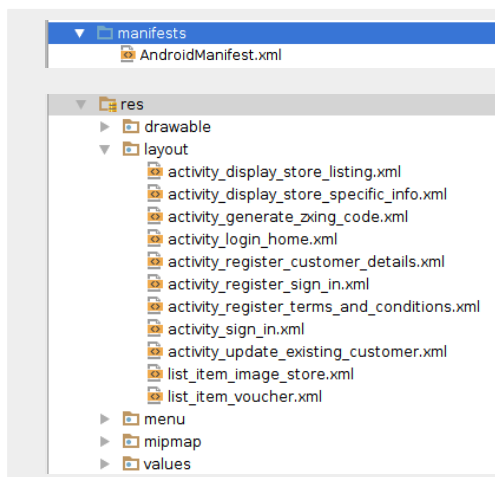
Manifest file → specifics activity flow : parent → child.

• /drawable → graphic files, e.g.: app and store logos.
• /layout → Specific layout for each activity.
• /menu → any menu specific files, e.g.: activity bar layout.
• /values → resource files for the app, e.g.: strings.xml.
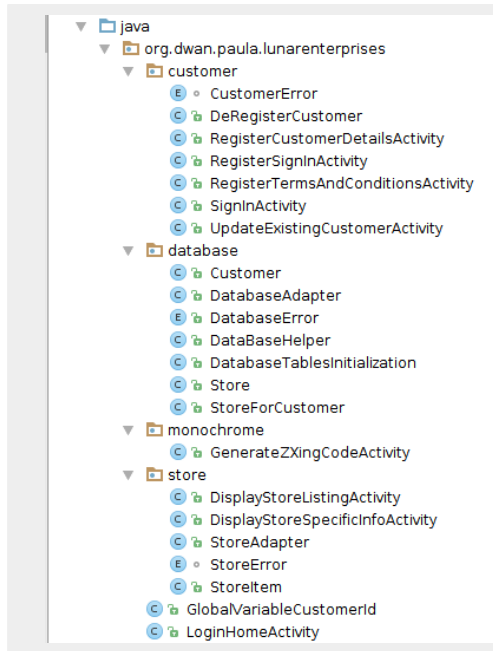
File and directory structure as implemented in Android Studio.

- org.dwan.paula.lunarenterprises → main project is which contains the Home Activity.
- org.dwan.paula.lunarenterprises.customer → all customer specific activities.
- org.dwan.paula.lunarenterprises.database → all database specific activities as well as helper and adapter.
- org.dwan.paula.lunarenterprises.monochrome → QR-Code / Bar-code generation activities.
- org.dwan.paula.lunarenterprises.store → all store specific activities.

Table 1:1 – Directory Structure (high-level overview of project structure as implemented)

1.5 APP FLOW – CHANGES TO COMMON IMPLEMENTATION

This section details any common changes with the app flow or functionality.

1.5.1 REASONS WHY?

Remove : *Bottom bar*	I removed the bottom bar for [HOME], [LOGOFF] and [CLOSE]. I instead added an overflow menu in the Action Bar, thus I then had the same functionality on each page and just checked that the customer was signed in (otherwise could not [Logoff]). I also changed the action name from [Logoff] to [Sign Out] to better match the initial option of [Sign In].
Remove : *Cancel Registration*	This activity was removed and replaced with an option in the Action Bar. This functionality was added to the Overflow menu present in every activity once the customer signs in or registers. Thus this functionality was easily accessible all the time and not just at one point in the process. The user is asked to confirm his/her password as additional confirmation.
Remove : *Facebook Login*	I did not have time to implement this. If this app is developed further (if some shops are interested) then it would be a good feature to have as the customer would not need to remember another login name and password. It would require updates to the database to validate live against Facebook as it would not be ideal to save the password and user name locally or in SQLite (the customer could update directly in Facebook or delete his/her facebook account).
Add : *Color Schemes*	[**New User**] → [**Existing User**] → [**Shops**] This ensured that each customer interaction was easily recognized. Different color implies different functionality and requirements on the customer and app.

1.5.2 ADVANTAGES OF CHANGES MADE

Remove : *Bottom bar*	Better use of screen space and the bottom of each screen was now available for the main layout. This also resulted in a cleaner display which is more in keeping with today's app's.
Remove : *Cancel Registration*	Removal of one activity – reduce app size and also simplify usage for the customer, just click the drop-down option to '*Yes! I want to cancel my registration.*'
Remove : *Facebook Login*	None really as it is reduced functionality. However it does simplify the app for the first iteration.
Add : *Color Schemes*	Improved appearance and customer should find it easier to recognize where he/she is when using the app.

1.5.3 DISADVANTAGES OF CHANGES MADE

Remove : *Bottom bar*	It is always possible to split the Action Bar where the screen size ensures that doing so improves legibility
Remove : *Cancel Registration*	None really.
Remove : *Facebook Login*	Reduced functionality.
Add : *Color Schemes*	Meant that rounded cell shapes had to be duplicated for each color scheme – taking more time to complete and also that I had to ensure the correct one was used in the appropriate activity / situation.

1.6 APP USAGE – DEVICES & ORIENTATIONS / LAYOUTS

Phone – typical	I restricted orientation to portrait as landscape does not really make sense when completing a form. The QR-Code was also generated in portrait layout while the Bar-code was generated as landscape only. The orientation reverted to portrait once the user returned to the previous activity or to home via the Activity Bar.
Tablet	The only difference between a phone and Tablet implementation would be placing the QR-Code / Bar-code to the right-hand side of the store listing.
	Registration of customer details activity should be retained as a separate activity, as should as actual customer sign-in. In future, more customer information may be requested at a later stage without impacting current design and also perhaps training videos on usage or an introductory offer from the store the customer is located in could be added to the right-hand side of the Register SignIn Activity later on.
	Currently, only average Android phones (mid-level → Samsung S4, Samsung Galaxy Note) as few shoppers would take a tablet with them while shopping. The most viable device would be S4 or similar in size, basically a regular android device.
Phone – small	Not covered as after checking on ZXing and displays on the small phones, the screen is too small for the bar-code or the QR-code to be legible for the scanners.
	Depending on the number of older devices in user and by whom (core customer group?), it may be required to send the bar-code using digits only by SMS or email. However, this would need to be looked at as the shop assistant would need to type in the code and this could slow down check-outs.

2.1   *A*CTIVITY – *W*ELCOME

2.1.1   *W*HAT THIS ACTIVITY DOES?

Home activity – this is first layout of the app where an existing user signs back in or a new user begins the registration process.

2.1.2   *V*IEW : *M*OCK-UP -V- *A*CTUAL

Mock-up	Actual
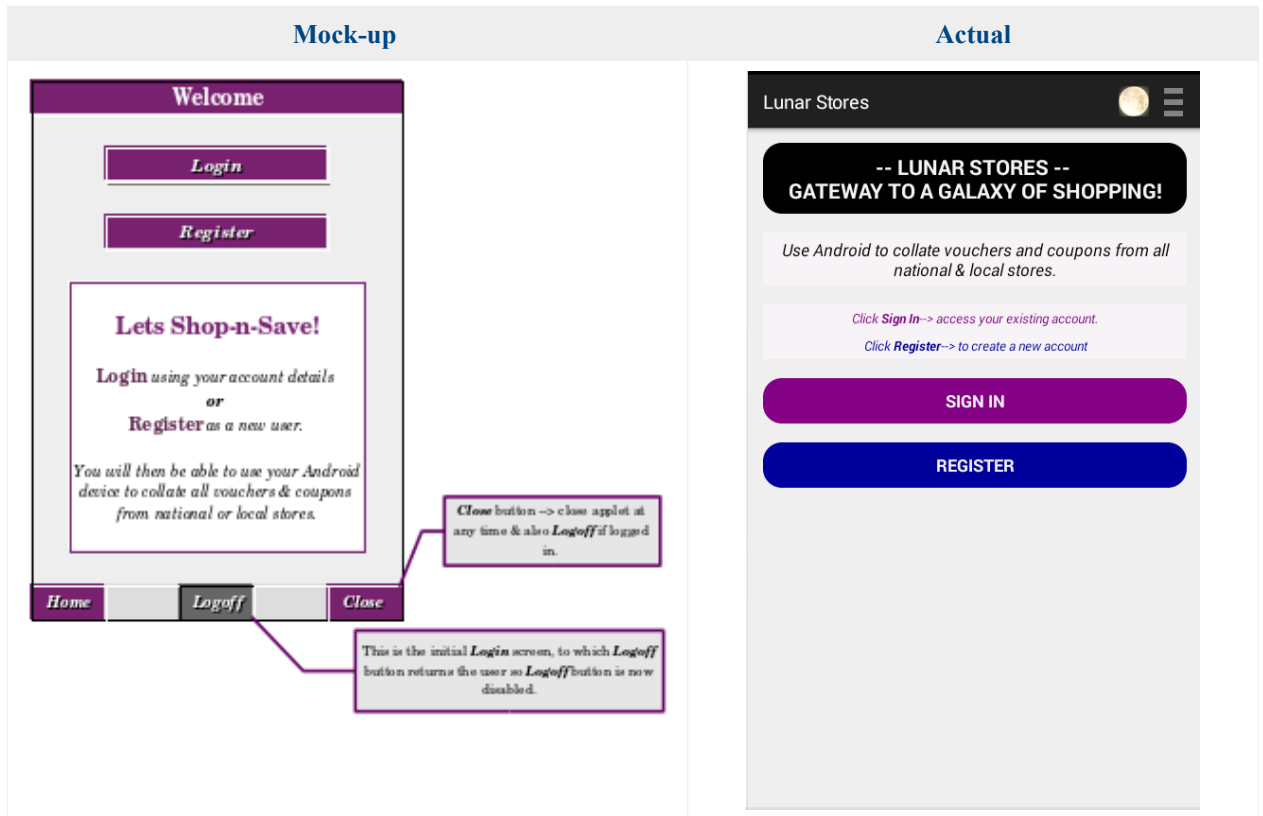
Table 2:1 – Lunar Store initial screen → Welcome screen

Difference/s	Common updates (see : <u>App Flow – Common Discrepancies</u>) and the following :
	1. The buttons were relocated to underneath the introductory text.
	2. The name of the app was changed.
Reason/s	1. The user will read from top to bottom so it makes more sense to have buttons underneath the introduction.
	2. No real reason just want a moon for an app logo.

2.1.3   CODE : LOGINHOMEACTIVITY.JAVA

LoginHomeActivity.java contains methods called for onClick listener for each button :

[Register]   Opens RegisterTermsAndConditionsActivity

Opens the T&C activity → once the new user agrees to the T&Cs as proposed, he/she can then register personal details and options in a new activity, followed by user name (unique) and password in a subsequent activity.

This listener, if implemented, calls the method :

```java
public void registerNewUser(View view) {
    Log.d(CLASS_NAME, "\t: register as new user, call new layout ...");

    Intent intentRegister = new Intent(getApplicationContext(),
     RegisterTermsAndConditionsActivity.class);
    startActivity(intentRegister);
}
```

[Sign In]   Opens SignInActivity

An existing user opens the sign-in activity and logs in using an existing user name and corresponding password.

This listener, if implemented, calls the method signInExistingUser, which calls the class SignInActivity.java with the intent intentSignin.

2.1.4   LAYOUT : ACTIVITY_LOGIN_HOME.XML

A <LinearLayout> was used for the overall display and all informational text strings were displayed using <TextViews>'s. In addition, there are two <Button>'s and each has an OnClick listener :

[Register] was formatted using *drawable/cell_round_navy.xml,* and had an OnCLick listener to call the RegisterContactDetails activity

[Sign In] was formatted using *drawable/cell_round_purple.xml,* and had an OnClick listener to call the SignIn activity

2.2   ACTIVITY – TERMS & CONDITIONS (NEW USER)

2.2.1   WHAT THIS ACTIVITY DOES?

Displays a summary of the Terms & Conditions to the potential customer. The user is asked to confirm that he/she has read and also understood the T&C's before the **[I Do Agree]** button is enabled. When clicked this button causes the RegisterContactDetails activity to open. The **[I Don't Agree]** button is always enabled and closes the app. As the user has not entered any details, there is no need to clear any information from the database or from the app.

2.2.2 VIEW : MOCK-UP -V- ACTUAL

Mock-up	Actual

Table 2:2 – Register New Customer → Agree to T&Cs

Difference/s	Common updates (see : App Flow – Common Discrepancies) also the flow was changed.
	From :
	To :
Reason/s	The user goes immediately to T&Cs and can decide if Lunar Stores is a viable app to use. Also, no details need to be stored and thus deleted if the user chooses [I Don't Agree] button. Until the user clicks on 'I confirm that I have read and understood the T&C's', the [I Do Agree] button is disabled. Once clicked, RegisterCustomerDetails activity opens.

2.2.3 CODE : REGISTERTERMSANDCONDITIONSACTIVITY.JAVA

LoginHomeActivity.java contains an onClickListener for each button :

[I Do Agree]	Opens RegisterContactDetailsActivity
	This listener, if implemented, calls the method AgreeToTermsAndConditions which basically opens the activity to register new customer activity.

```java
public void AgreeToTermsAndConditions(View view) {
    Log.d(CLASS_NAME, "\t: Agree to T&C's, call new layout ...");
    Intent intentRegisterDetails = new Intent(getApplicationContext(),
     RegisterCustomerDetailsActivity.class);
    startActivity(intentRegisterDetails);
}
```

[I Don't Agree] Closes the app → basically calls finish() and closes database if open.

```java
public void DoNotAgreeToTermsAndConditions(View view) {
    Log.d(CLASS_NAME, "\t: Do Not Agree to T&C's, finish ...");

    finish();
}
```

2.2.4 LAYOUT : ACTIVITY_REGISTER_TERMS_AND_CONDITIONS.XML

A <TableLayout> was used for the overall display. This was embedded in a <ScrollView> ensuring that any items off screen initially could be scrolled to by the user.

In order to fake the bullets in the left cell using *drawable/cell_round_nay_bullet.xml*. All T&C text strings were displayed using <TextViews>, and Multiple Line display was enabled in case needed – depending on device.

```xml
<TableRow ... ... ...>
    <TextView
        android:id="@+id/textviewTandCBullet01"
        android:background="@drawable/cell_round_navy_bullet"
        android:gravity="center_horizontal"
        android:text="@string/tvTandCsBullet"
        android:textColor="@color/grey_pale"
        android:textStyle="bold"></TextView>
    <TextView
        android:id="@+id/textviewTandC01"
        android:layout_weight="1"
        android:ems="5"
        android:maxLines="10"
        android:padding="5dp"
        android:singleLine="false"
        android:text="@string/tvTermConditions01"
        android:textAppearance="@android:style/TextAppearance.Small"
        android:textStyle="italic"></TextView>
</TableRow>
```

Where no bullets applied then the string spanned two cells, with a null spacer in the first cell.

```xml
<TableRow ... ... ...>
    <TextView android:id="@+id/nullStr02"></TextView>
    <TextView
        android:id="@+id/textviewTandCSummary"
        android:layout_span="2"
        android:layout_weight="1"
        android:background="@color/grey_pale"
        android:maxLines="5"
        android:padding="5dp"
        android:singleLine="false"
        android:text="@string/tvTermConditionsIntro02"
        android:textColor="@color/blue_dark"
        android:textStyle="bold"></TextView>
</TableRow>
```

There are two <Button>'s and each has an OnClick listener :

[I Do Agree] was formatted using *drawable/cell_round_navy.xml,*

[I Don't Agree] was formatted using *drawable/cell_round_grey.xml.*

2.3 ACTIVITY – REGISTER CUSTOMER CONTACT DETAILS (NEW USER)

2.3.1 WHAT THIS ACTIVITY DOES?

Once the user has entered contact information and checked (or not) SMS, Email or 3rd party contact then he/she may click on Submit, the data is retained and the new customer is then in this activity, is asked to provide a user name and password.

Rather than detailed help functionality – separate ReadMe or help activity – I used hints for each <EditText> field.

2.3.2 VIEW : MOCK-UP -V- ACTUAL

Table 2:3 – Register Customer New Customer → Contact details with blank details

Table 2:4 – Register New Customer → Contact details with fields and check boxes completed

Difference/s	Common updates (see : App Flow – Common Discrepancies) also the flow was changed.
	It was initially thought to have all <TextEdit> and <CheckBox> disabled until the T&C's had been agreed to. This was changed to a flow revision, which is explained in section View : Mock-up -v- Actual of Activity – Terms & Conditions (New User)
Reason/s	Improve flow by moving T&C's and also improved functionality / user experience by implementing common updates.

2.3.3 CODE : REGISTERCONTACTDETAILSACTIVITY.JAVA

[Submit] The customer details as entered are validated and if okay are added to an intent which is sent to a new activity where he/she provides user name (unique) and password.

```java
public void SubmitCustomerContactDetails(View view) {
    Log.d(CLASS_NAME, "\t: accept and save customer details, call new
        layout ...");
    Intent intentRegisterDetails = new Intent(getApplicationContext(),
        RegisterSignInActivity.class);
    intentRegisterDetails.putExtra(CUST_NAME1, etName1.toString());
    intentRegisterDetails.putExtra(CUST_NAME2, etName2.toString());
    intentRegisterDetails.putExtra(CUST_ADDRESS1, etAddress1.toString());
    intentRegisterDetails.putExtra(CUST_ADDRESS2, etAddress2.toString());
    intentRegisterDetails.putExtra(CUST_ADDRESS3, etAddress3.toString());
    intentRegisterDetails.putExtra(CUST_ADDRESS4, etAddress4.toString());
    intentRegisterDetails.putExtra(CUST_EMAIL, etEmail.toString());
    intentRegisterDetails.putExtra(CUST_MOBILE, etMobile.toString());
    intentRegisterDetails.putExtra(CUST_EMAIL_OKAY, emailOkay.toString());
    intentRegisterDetails.putExtra(CUST_MOBILE_OKAY, smsOkay.toString());
    intentRegisterDetails.putExtra(CUST_3PARTY_OKAY, thirdPartyOkay.toString());
    startActivity(intentRegisterDetails);
}
```

[Clear All] All <EditText> strings as entered, are cleared, for example :

```java
etMobile.getText().clear();
```

All <CheckBox> as clicked, are cleared, for example :

```java
chkAllowSMS.setChecked(false);
```

Values of <CheckBox> for SQLite database are also reset to 0 → false, for example :

```java
smsOkay = "0";
```

There are also private validation methods; e.g.: Reg-ex of strings entered, Email is valid form using android.util.Patterns, if allow contact by email is clicked that an email is provided; which are used by validateActivityFields(). Validation is carried out in the validateActivityFields method and once completed the **[Submit]** button is available.

The values for the <EditText> fields and the equivalent int values for SMS, Email and 3rd Party contact allowed (TRUE = 1 | FALSE = 0) are saved for later addition to the database.

As previously, the Action Bar was created and as the user has not yet registered, the <De-Register> option is not available.

2.3.4 LAYOUT : ACTIVITY_REGISTER_CONTACT_DETAILS.XML

Again, I used a <TableLayout> embedded in a <ScrollView>with column 1 used for titles such as <Name>, <Address>, <Mobile>, and <Email>. These were all <TextField> formatted using *drawable/cell_round_navy.xml*. Column 2 contained the <EditText> fields which were used to retrieve the customers contact details. Column 2 was also used for the <CheckBox> options permitting contact via SMS, Email or from 3rd parties. Two buttons applied :

[Submit] was formatted using *drawable/cell_round_navy.xml,* and had an onClick listener assigned.

[Clear All] was formatted using *drawable/cell_round_grey.xml,* and had an onClick listener assigned.

2.4 ACTIVITY – REGISTER SIGNIN DETAILS (NEW USER)

2.4.1 WHAT THIS ACTIVITY DOES?

The new customer provides a user name and password, which is confirmed to ensure the user knows what he/she typed. The original password and the confirmation password are checked if equal, if not the user is asked to re-input them. The customer name is checked that it is lower case. Finally, both user name and login are checked for uniqueness. Once all validations are completed, the user contact details as well as user name and password are added to the SQLite database.

2.4.2 VIEW : MOCK-UP -V- ACTUAL
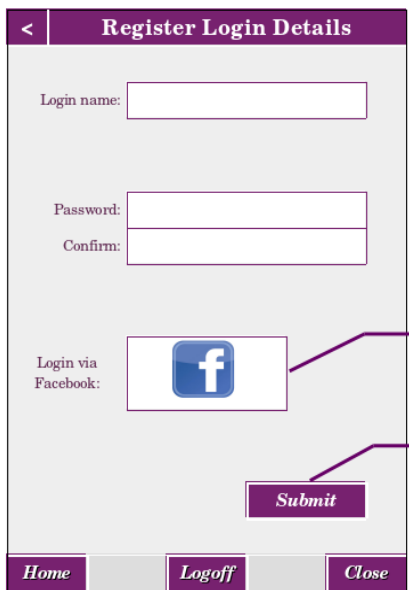
Mock-up	Actual

Table 2:5 – Register New Customer → Add login details

Difference/s	Common updates (see : App Flow – Common Discrepancies).
Reason/s	N/A

2.4.3 CODE : REGISTERSIGNINDETAILSACTIVITY.JAVA

In the previous activity the user provided his contact details which were validated for not Null, length and adhering to Reg-ex formatting (email, phone). No details were validated against the database. A customer may want the option of opening a second account, thus duplication of contact details is not relevant. However, sign-in details must be unique, duplicate passwords for different users are allowed, but user names must be unique. Again the Submit button is enabled once validation is completed.

[Submit]

```
t.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_NAME2));
    customer.setAddress1(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_ADDRESS1));
    customer.setAddress2(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_ADDRESS2));
    customer.setAddress3(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_ADDRESS3));
    customer.setAddress4(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_ADDRESS4));
    customer.setMobile(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_MOBILE));
    customer.setEmail(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_EMAIL));
    customer.setEmailOk(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_EMAIL_OKAY));
    customer.setMobileOk(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_MOBILE_OKAY));
    customer.setThirdPartyOk(intent.getStringExtra
        (RegisterCustomerDetailsActivity.CUST_3PARTY_OKAY));
    }
    btnRegisterSubmit = (Button) findViewById(R.id.buttonSignInSubmit);
    btnRegisterSubmit.setEnabled(false);
    if (validateAnyEditFieldUsed(new EditText[]{etNewUser, etNewPassword})) {
        if (validateActivityFields()) {
            customer.setNameLogin(etNewUser.getText().toString());
            customer.setPasswordLogin(etNewPassword.getText().toString());
            btnRegisterSubmit.setEnabled(true);
        }
    }
}
```

Added to customer.tb table in database :

```
public void registerCustomerSQLDetails(View view) {
    Log.d(CLASS_NAME, "\t: validate & register new customer in SQL
database ...");
    databaseAdapter = new DatabaseAdapter(this);
    try {
        databaseAdapter.open();
    } catch (SQLException e) {
        Log.d(CLASS_NAME, "\t: onCreate - register new user - SQL exception...");
        e.printStackTrace();
    }
    databaseAdapter.createCustomer(customer);
}
```

[Clear All] User name and password (Enter and confirm) are reset to the defaults, for example :

```
etNewUser.getText().clear();
```

2.4.4   LAYOUT : ACTIVITY_REGISTER_SIGN_IN_DETAILS.XML

Again, I used a <TableLayout> with column 1 used for titles <User Name> and <Password>. These were all <TextField> formatted using *drawable/cell_round_navy.xml*. The <TableLayout> was enclosed in a <ScrollView> in case needed. Column 2 contained the <EditText> fields which were used to retrieve the customers user name, initial password and the same password for confirmation. As previously, there were two buttons :

[Submit] was formatted using *drawable/cell_round_navy.xml,* and had an onClick listener assigned.

[Clear All] was formatted using *drawable/cell_round_grey.xml,* and had an onClick listener assigned.

2.5   ACTIVITY – SIGN IN (EXISTING USER)

2.5.1   WHAT THIS ACTIVITY DOES?

The existing user signs in using an existing user name and password. The Store Listing activity then opens with existing information and points saved to current date.

Mock-up	Actual
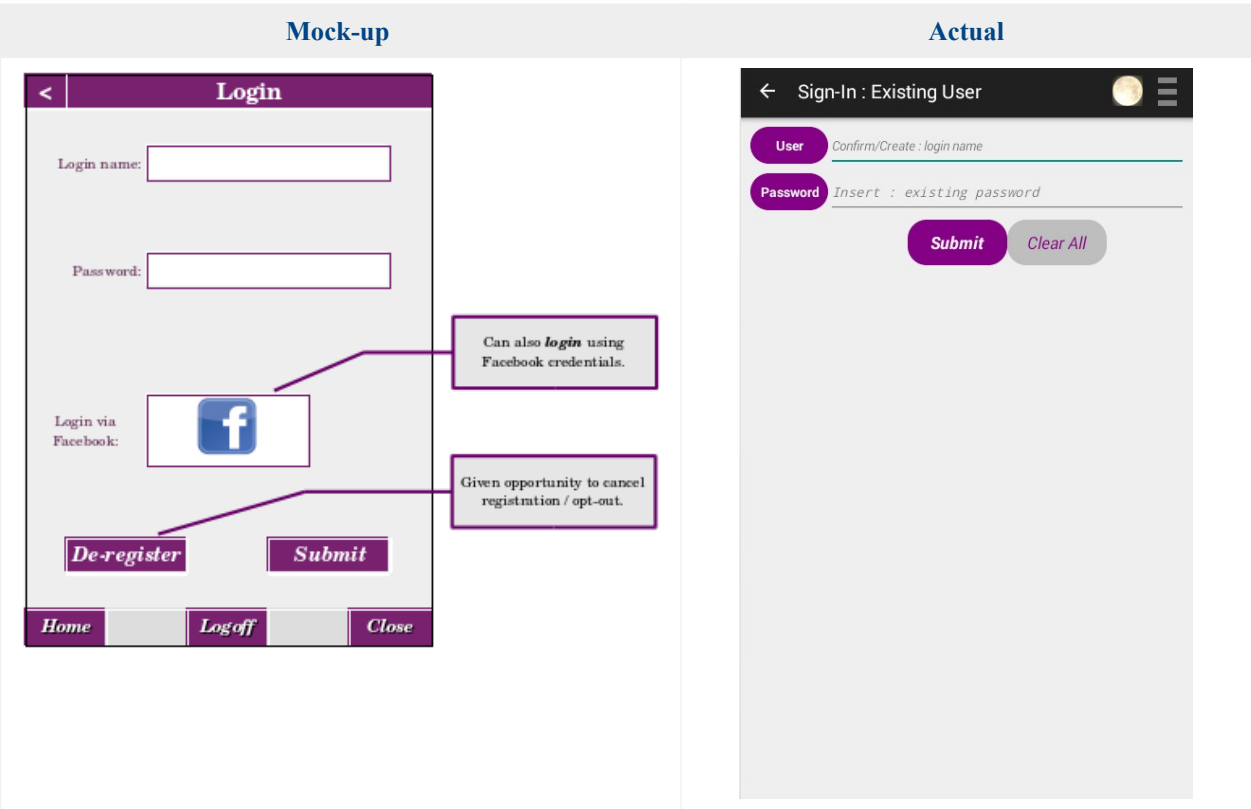
Table 2:6 – Existing User SignIn

Difference/s	Common updates (see : App Flow – Common Discrepancies) and De-register was moved to the common Action Bar. Also as in Register Customer Login Details, a Clear All button was added to reset Login Name and Password to default values.
Reason/s	Improved functionality and ease of customer use.

2.5.3   CODE : SIGNINACTIVITY.JAVA

The user provides his/her sign-in name and associated password which are validated for not Null, and against the database. Again validation is completed once the Submit button is clicked.

[Submit]	The customer user name and password as entered are validated against the SQLite database for that customer.

```java
private void populateActivityFields() {
    Log.d(CLASS_NAME, "\t: populateActivityFields : with values as entered by
      user ...");

    etUser = (EditText) findViewById(R.id.edittextUserLoginName);
    etUserPassword = (EditText) findViewById(R.id.edittextUserLoginPassword);
    btnSignInSubmit = (Button) findViewById(R.id.buttonSignInSubmit);
    btnSignInSubmit.setEnabled(false);
    if (validateAnyEditFieldUsed(new EditText[]{etUser, etUserPassword})) {
        if (validateActivityFields()) btnSignInSubmit.setEnabled(true);
    }
}
```

If valid then the store listing activity now opens and the customer may start using the app.

```
public void submitCustomerSQLDetails(View view) {
    Log.d(CLASS_NAME, "\t: validate sign-in details as entered by existing
        customer & open next activity...");

    Customer customer = new Customer();
    final GlobalVariableCustomerId globalVariableCustomerId =
        (GlobalVariableCustomerId) getApplicationContext();

    customer = databaseAdapter.getCustomerUsingUserName
        (etUser.getText().toString());
    globalVariableCustomerId.setCustId(customer.getId());
    Intent intentSignInDetails = new Intent(getApplicationContext(),
        DisplayStoreListingActivity.class);
    startActivity(intentSignInDetails);
}
```

[Clear All]	User name and password are reset to the defaults, for example :

```
etNewUser.getText().clear();
```

2.5.4 LAYOUT : ACTIVITY_SIGN_IN.XML

Again, I used a <TableLayout> with column 1 used for titles <User Name> and <Password>. These were all <TextField> formatted using *drawable/cell_round_purple.xml*. The <TableLayout> was enclosed in a <ScrollView> in case needed. Column 2 contained the <EditText> fields which were used to retrieve the customers name and password. As previously, the two buttons :

[Submit] was formatted using *drawable/cell_round_purple.xml,* and had an onClick listener assigned.

[Clear All] was formatted using *drawable/cell_round_grey.xml,* and had an onClick listener assigned.

2.6 ACTIVITY – CANCEL REGISTRATION (EXISTING USER)

2.6.1 VIEW : MOCK-UP -V- ACTUAL

Mock-up	Actual
	Activity Bar / menu options → Listing of common options →
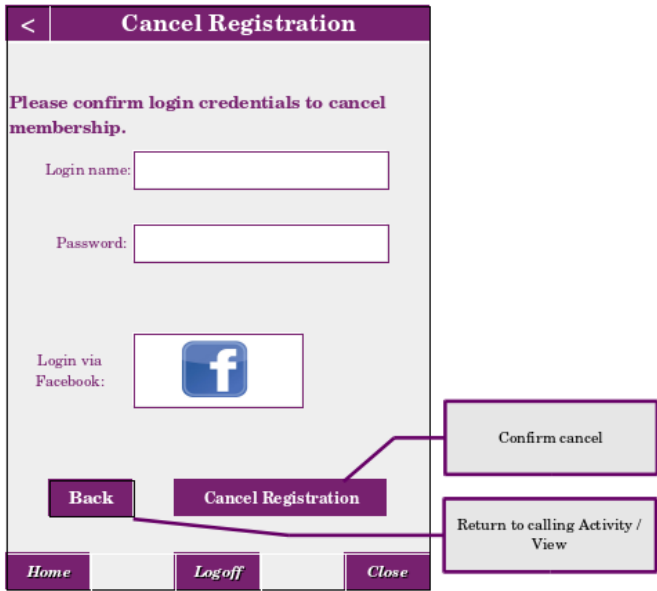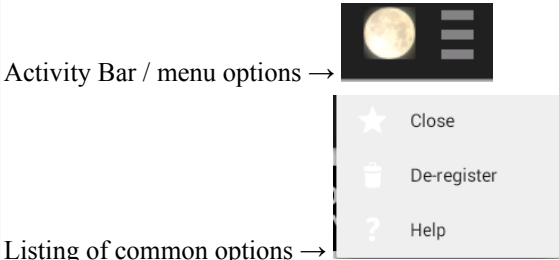
Table 2:7 – Cancel Registration Activity → replaced with ActionBar OverFlow menu option.

Difference/s	Deleted activity altogether → I used an Activity Bar menu drop-down option listing of Close | De-register | Help. This option listing is now available throughout the app so the user no longer needs to navigate to a specific activity to de-register.
Reason/s	The user has already logged in, so it makes more sense to just use an option in the Activity Bar drop down and request the use to confirm his/her request to cancel registration.

2.7 ACTIVITY – STORE LISTING : ADD / USE (NEW & EXISTING USERS)

2.7.1 WHAT THIS ACTIVITY DOES?

Provides a listing **(i)** stores the customer collects points from currently and listing **(ii)** additional stores available. Customer then selects a store from listing **(i)** to see current balance and use points if applicable and if wished and from listing **(ii)** to add that store to the list of stores he/she collects points from.

2.7.2 VIEW : MOCK-UP -V- ACTUAL

Mock-up	Actual
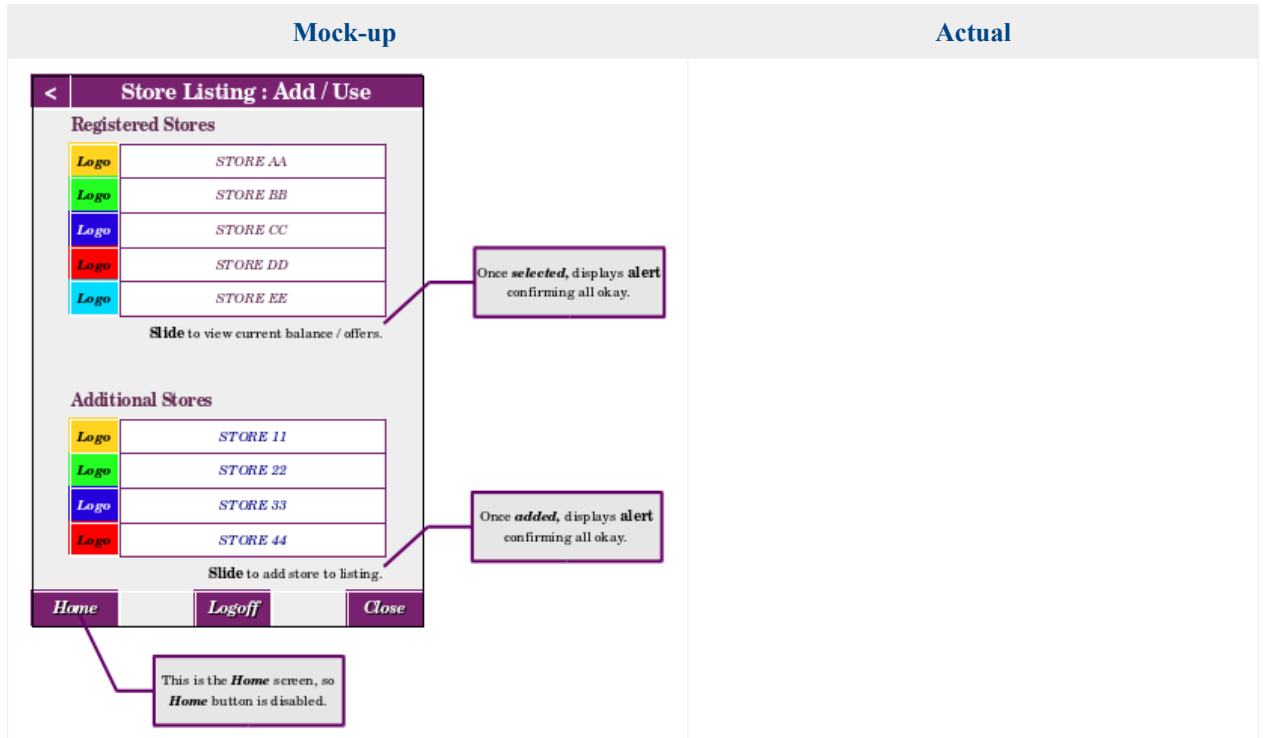
Table 2:8 – Store Listing → those in use and additional ones available.

Difference/s	Common updates (see : <u>App Flow – Common Discrepancies</u>).
	1. Slide was not enabled, click on the list item was instead.
	2. Also the store listing is now combined, existing stores and additional stores are now combined.
Reason/s	1. Easier for user to note what item he/she selected and thus less likelihood of error on smaller screens.
	2. Instead if the store is not present in StoresForCustomer.tb the user is offer the option to start collecting for that store. Easier implementation and more suited to a good user experience.

2.7.3 CODE : DISPLAYSTORELISTING.JAVA

Once the activity opens, populateListViewStores is called by onCreate. This creates a listing of all stores available (i.e.: currently in store.tb)

```java
private void populateListViewStores() {
    Log.d(CLASS_NAME, "\t: populateListViewStores for all stores ...");

    int i = 0;
    for (Store store : stores) {
        storeImages[i] = Integer.parseInt("R.drawable" + store.getLogo()); //mipmap?
        storeNames[i] = store.getName().toString();
        i++;
    }
    storeItems = new ArrayList<StoreItem>();
    for (int x = 0; x < storeImages.length; x++) {
        StoreItem item = new StoreItem(storeImages[x], storeNames[x]);
        storeItems.add(item);
    }
```

```
    storeListView = (ListView) findViewById(R.id.storeList);
    storeListView.setAdapter(new StoreAdapter(this, R.layout.list_item_image_store,
        storeItems));
    storeListView.setOnItemClickListener(this);
}
```

When a store is selected then the global customer name is obtained and together with the store id, the points balance is verified. This is initialized to -1 in the method which if returned confirms that the customer is not collecting points for that store. She/he is offered to do so in the next activity if wished.

```
public void onItemClick(AdapterView<?> parent, View view, int position, long _id) {
    Log.d(CLASS_NAME, "\t: onItemClick for selected row ...");
    int imageId = storeImages[position];
    String name = storeNames[position];
    int storeId = databaseAdapter.getStoreIdUsingStoreName(name);
    final GlobalVariableCustomerId globalVariableCustomerId = (GlobalVariableCustomerId)
        getApplicationContext();
    int points = databaseAdapter.getStorePointsBalanceUsingStoreId
        (storeId,globalVariableCustomerId.getCustId());
    if (points == 0)
        Toast.makeText(getApplicationContext(), StoreError.ERROR9003,
            Toast.LENGTH_SHORT).show();
    else if (points == -1)
        Toast.makeText(getApplicationContext(), StoreError.ERROR9004,
            Toast.LENGTH_SHORT).show();
    Intent intentStoreListing = new Intent(this, DisplayStoreSpecificInfoActivity.class);
    intentStoreListing.putExtra(STORE_IMAGE, imageId);
    intentStoreListing.putExtra(STORE_NAME, name);
    intentStoreListing.putExtra(STORE_POINTS, points);
    startActivity(intentStoreListing);
}
```

2.7.4   LAYOUT : ACTIVITY_DISPLAY_STORE_LISTING.XML

This uses a <ListView> of image (store logo) and store name as defined *list_item_image_store.xml.*

Other <List View> files are explained in section : Store ListView Files.

2.8 ACTIVITY – STORE STATUS [STORE_NAME] (NEW & EXISTING USER)

2.8.1 WHAT THIS ACTIVITY DOES?

This displays current points available and also any money-off or %-off vouchers which may be redeemed for the selected store. If any available voucher is selected by the customer then a QR-code or Bar-code (depending) on user selected is generated in the next activity.

2.8.2 VIEW : MOCK-UP -V- ACTUAL

Mock-up	Actual
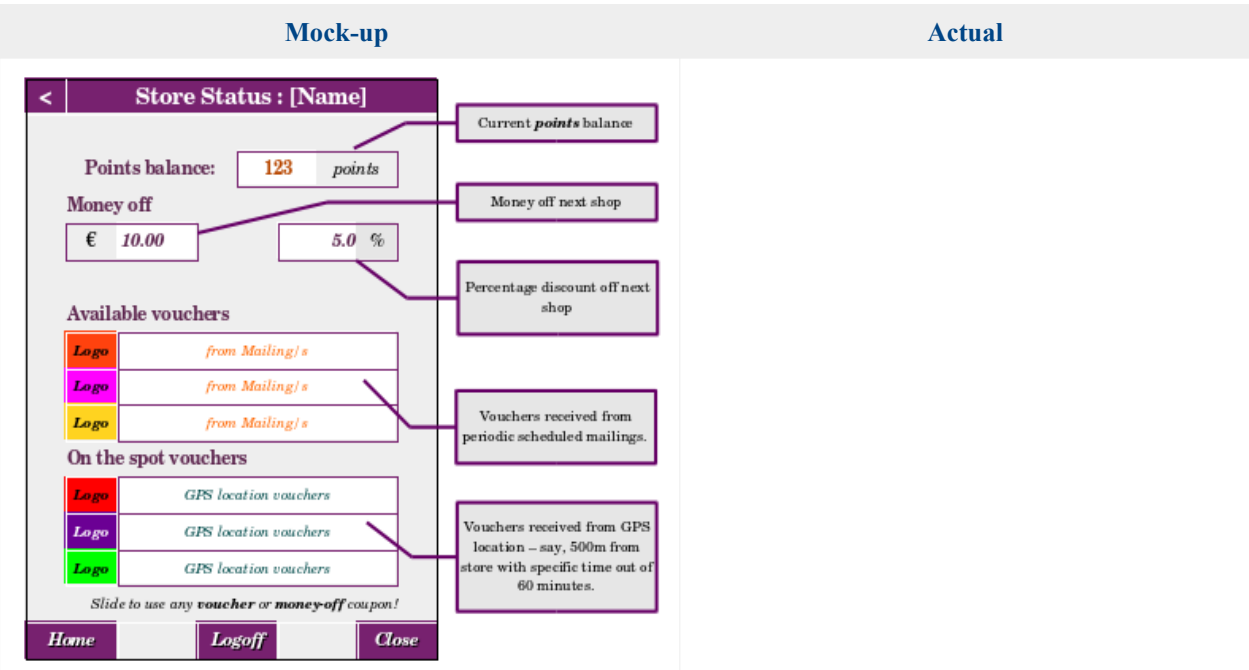
Table 2:9 – Store Status → available points and offers.

Difference/s	Common updates (see : App Flow – Common Discrepancies).
	1. GPS vouchers options removed as not enough time to implement this functionality. It would be a good add-on in the future.
Reason/s	1. Insufficient time.

2.8.3 CODE : DISPLAYSTORESPECIFICINFO.JAVA

This again uses a <ListView> but for the vouchers – for this iteration. It is a simple application of set number of points equates to voucher (money-off or percentage-off). Also displayed is the store logo and name as well as points balance.

```java
private void populateStoreIntent(Intent intent) {
    Log.d(CLASS_NAME, "\t: populateStoreIntent ...");

    int imageId = -1;
    int pointsBalance = 0;
    if (intent != null) {
        store = intent.getStringExtra(DisplayStoreListingActivity.STORE_NAME);
        image = intent.getStringExtra(DisplayStoreListingActivity.STORE_IMAGE);
        imageId = getResources().getIdentifier(image, "drawable", getPackageName());
        pointsBalance = Integer.parseInt(intent.getStringExtra
            (DisplayStoreListingActivity.STORE_POINTS));
    }
    ImageView tvImage = (ImageView) findViewById(R.id.imageivewImageName);
    tvImage.setImageResource(imageId);
    TextView tvStore = (TextView) findViewById(R.id.textviewStoreName);
    tvStore.setText(store);
    TextView tvPoints = (TextView) findViewById(R.id.textviewPoints);
    tvPoints.setText(pointsBalance);
    String[] vouchersListing = new String[] {"Null Voucher"};
```

```
        if (pointsBalance >= 1000)
            vouchersListing[vouchersListing.length] = "20% voucher";
        else if (pointsBalance >= 750) {
            vouchersListing[vouchersListing.length] = "10% voucher";
        } else if (pointsBalance >= 500) {
            vouchersListing[vouchersListing.length] = "€10 voucher";
        } else if (pointsBalance >= 250) {
            vouchersListing[vouchersListing.length] = "€5 voucher";
        }
        ArrayAdapter<String> voucherAdapter = new ArrayAdapter<String>(this,
                R.layout.activity_display_store_specific_info, vouchersListing);
        listViewVouchers = (ListView) findViewById(R.id.listViewVouchers);
        listViewVouchers.setAdapter(voucherAdapter);
        listViewVouchers.setOnItemClickListener(new AdapterView.OnItemClickListener() {
            @Override
            public void onItemClick(AdapterView<?> parent, View view, int position, long id) {
                TextView tvVoucher = (TextView) findViewById(R.id.textviewVoucher);
                voucherDescription = tvVoucher.getText().toString();
            }
        });
}
```

If a store which is selected is not in use then the user is given the option to add that store to the store4customer.tb using the button OnClickListener for **[Add Store]** :

```
public void startCollectingPoints(){
    int storeId = databaseAdapter.getStoreIdUsingStoreName(store);
    final GlobalVariableCustomerId globalVariableCustomerId = (GlobalVariableCustomerId)
        getApplicationContext();
    int points = databaseAdapter.getStorePointsBalanceUsingStoreId
        (storeId,globalVariableCustomerId.getCustId());
    if (points == -1)
        databaseAdapter.createStoreForCustomerPoints
            (storeId,globalVariableCustomerId.getCustId(), 0);          // start collecting
    else if (points >= 0)
        Toast.makeText(getApplicationContext(), StoreError.ERROR9005,
            Toast.LENGTH_SHORT).show();                                 // oops → error
}
```

2.8.4 LAYOUT : ACTIVITY_DISPLAY_STORE_SPECIFIC_INFO.XML

Again, I used a <TableView> inside a <ScrollView>. This will facilitate screen scrolling, if needed.

In the first row, there is the store logo → <ImageView>. and store name → <TextView>. In the next row, we have the current points balance and actual points available / collected to date (both → <TextView>). In the third row, we have available vouchers for that store. If one is selected then the QR-code and Bar-code are generated in the next activity.

[Add Store] was formatted using *drawable/cell_round_green.xml* and called startCollectingPoints when clicked.

[Cancel] was formatted using *drawable/cell_round_grey.xml* and closed the app when clicked.

2.9 ACTIVITY – BAR-CODE (NEW & EXISTING USER)

2.9.1 WHAT THIS ACTIVITY DOES?

This displays the QR-code or the Bar-code for the selected voucher.

2.9.2 VIEW : MOCK-UP -V- ACTUAL

Mock-up	Actual
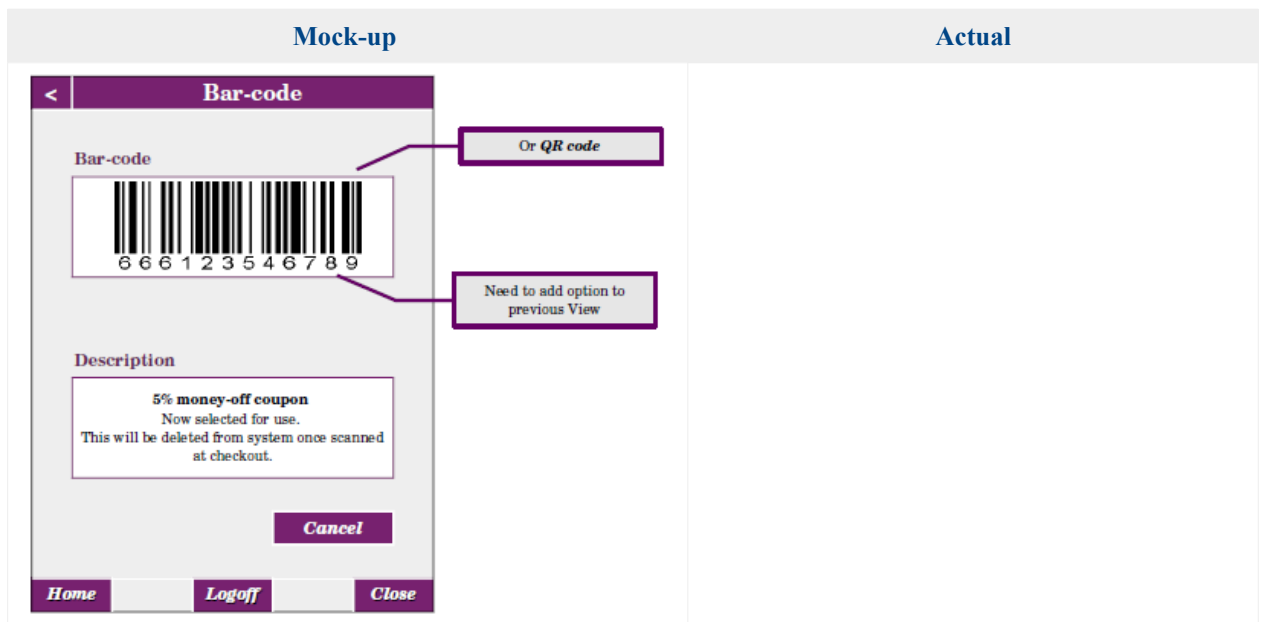
Table 2:10 – Generate QR-Code & Bar-Code for selected item.

Difference/s	Common updates (see : App Flow – Common Discrepancies).
	1. Addition of both QR-code and Bar-code to the same screen.
	2. Disabled the the Title / Activity bar.
Reason/s	1. Customer has the option to use both depending on store facilities.
	2. Not needed in this activity and it all maximizes screen real-estate and makes the app look better.

2.9.3 CODE : GENERATEZXINGCODEACTIVITY.JAVA

Title bar was disabled for this activity using :

```
requestWindowFeature(Window.FEATURE_NO_TITLE);
getWindow().setFlags(WindowManager.LayoutParams.FLAG_FULLSCREEN,
WindowManager.LayoutParams.FLAG_FULLSCREEN);
setContentView(R.layout.activity_generate_zxing_code);
```

Depending on the option chosen in the previous activity, the QR-code and the Bar-code for the voucher are displayed for use. The following is the code for QR-code generation. There are many similarities to that for Bar-code, differences to Bar-code are marked in green.

```
private void generateQRCode(String data) {
    Log.d(CLASS_NAME, ":\tgenerateQRCode ...");

    int xRange = 150, yRange = 150;
    int colorBack = 0xFF000000, colorWhite = 0xFFFFFFFF;
    Writer qrWriter = new QRCodeWriter();
    String finalData = Uri.encode(data, "utf-8");
    try {
        BitMatrix bitMatrix = qrWriter.encode(finalData, BarcodeFormat.QR_CODE, xRange, yRange);
        Bitmap imageBitmap = Bitmap.createBitmap(xRange, yRange, Bitmap.Config.RGB_565);
        for (int x = 0; x < xRange; x++) {
            for (int y = 0; y < yRange; y++) {
                imageBitmap.setPixel(x, y, bitMatrix.get(x, y) ? colorBack : colorWhite);
            }
        }
        ImageView imageview = (ImageView) findViewById(R.id.imageviewQRcode);
        if (imageBitmap != null) imageview.setImageBitmap(imageBitmap);
```

```
    } catch (WriterException e) {
       e.printStackTrace();
    }
}
```

For Bar-code format, we have :

- xRange → *180* pixels
- yRange → *40* pixels
- writer → *'MultiFormatWriter barWriter = new MultiFormatWriter();'*
- BarcodeFormat → *'BarcodeFormat.CODE_128'*

Of course, the log.d string an also the id of the <ImageView> are also amended

2.9.4 LAYOUT : ACTIVITY_GENERATE_ZXING_CODE.XML

<ScrollView> containing a <LinearLayout> containing the store name, together with the imge of the Bar-code and the QR-code and also a **[Cancel]** button which returns to ***DisplayStoreSpecificInfoActivity.***

2.10 COMMON FILES USED

2.10.1 XML FILES

values/ strings.xml	This is a listing of all strings used in the project : Button, CheckBox, EditText, TextView, Hint. Some strings were formatted for HTML display … , other strings used formatting via the layout .xml file (TextSize, TextAppearance, etc). This meant that theoretically in a real app – any updates to the contents of or display of any string could be completed by a UX engineer.
values/ colors.xml	This file contains all colors used in the project. Having a common file for use throughout ensured that any variants in shading were applied to all usages.

Table 2:11 – Common XML files in the app.

Rounded buttons were used throughout to ensure continuity throughout the app and to provide a common *look-n-feel*. The easiest way to do so was to define a drawable shape, with specific color depending on where is app flow customer is.

drawable/ cell_round_green.xml	**Green** was used for stores
	
	``xml
	1 <?xml version="1.0" encoding="UTF-8"?>
	2
	3 <!--...-->
	11
	12 <shape xmlns:android="http://schemas.android.com/apk/res/android">
	13 <solid android:color="@color/green"/>
	14 <corners android:radius="20px"/>
	15 <padding android:top="10dp" android:bottom="10dp" android:right="10dp" android:left="10dp"/>
	16 </shape>
	``

drawable/ cell_round_purple.xml	**Purple** was used for existing customers.
	
	``xml
	12 <shape xmlns:android="http://schemas.android.com/apk/res/android">
	13 <solid android:color="@color/purple" />
	``

drawable/ cell_round_navy.xml	**Navy** was used for new customers.
	
	``xml
	12 <shape xmlns:android="http://schemas.android.com/apk/res/android">
	13 <solid android:color="@color/blue_dark" />
	``

drawable/ cell_round_black.xml	**Black** was used for Lunar Stores references
	
	``xml
	12 <shape xmlns:android="http://schemas.android.com/apk/res/android">
	13 <solid android:color="@color/black" />
	``

drawable/ cell_round_grey.xml	**Grey** was used for Cancel, No, etc.
	
	``xml
	12 <shape xmlns:android="http://schemas.android.com/apk/res/android">
	13 <solid android:color="@color/grey" />
	``

drawable/ cell_round_navy_bullet.xml	This was used to fake the bullets for the Terms & Conditions activity – only difference between this and *drawable/cell_round_navy.xml* is the size of the padding "10dp" → "2dp".
	
	``xml
	15 <padding android:bottom="2dp" android:left="5dp" android:right="5dp" android:top="2dp" />
	16 </shape>
	``

Table 2:12 – Common table titles and button formatting XML files in the app.

2.10.2 SQLITE FILES

DataBaseHelper.java	This works on the database itself for onCreate object (is it a new or existing database?) and onUpgrade (structure changes, version incremented, version decremented).
	
	``java
	public void onCreate(SQLiteDatabase db) {
	  Log.d(CLASS_NAME, ":\t onCreate - create three tables in SQLite
	    database...");
	
	  db.execSQL(CREATE_TABLE_STORE);
	  db.execSQL(CREATE_TABLE_CUSTOMER);
	  db.execSQL(CREATE_TABLE_SHOP_FOR_CUSTOMER);
	}
	``
	
	and
	
	``java
	public void onUpgrade(SQLiteDatabase db, int oldVersion,
	    int newVersion) {
	  Log.d(CLASS_NAME, ":\t onUpgrade inc. recreate three tables for
	    SQLite ...");
	
	  db.execSQL("DROP TABLE IF EXISTS " + TABLE_STORE);
	  db.execSQL("DROP TABLE IF EXISTS " + TABLE_CUSTOMER);
	  db.execSQL("DROP TABLE IF EXISTS " + TABLE_SHOP_FOR_CUSTOMER);
	  onCreate(db);
	}
	``
	
	Basically, the SQLite Schema!

DatabaseAdapter.java	This is responsible for managing the SQLite database data. It is used by the app to insert, update, delete and query data from the SQLite database tables : customer.tb, store.tb and shop4customer.tb. Basically, CRUD functionality as well as close the database once done.
	For example : delete data from a table using the PK (id) for the table :
| | ```java
public void deleteStore(long store_id) {
  Log.d(CLASS_NAME, ":\t delete store for specified store id ...");

  SQLiteDatabase db = dbHelper.getWritableDatabase();
  db.delete(TABLE_STORE, KEY_ID + " = ?", new String[]
    { String.valueOf(store_id) });
}
``` |

Table 2:13 – 3-Level SQLite files as applied.

2.10.3 STORE LISTVIEW FILES

StoreAdapter.java	Adapter for the store items for the listing :
| | ```java
public View getView(int position, View view, ViewGroup parent) {
  StoreHolder storeHolder = null;

  LayoutInflater layoutInflater = (LayoutInflater)
    context.getSystemService(Activity.LAYOUT_INFLATER_SERVICE);
  if (view == null) {
    view = layoutInflater.inflate(R.layout.list_item, null);
    storeHolder = new StoreHolder();
    storeHolder.image_icon = (ImageView)
      view.findViewById(R.id.image_icon );
    storeHolder.text_store = (TextView)
      view.findViewById(R.id.text_store );
    view.setTag(storeHolder);
  } else {
    storeHolder = (StoreHolder) view.getTag();
  }
  StoreItem storeItem = getItem(position);
  storeHolder.image_icon.setImageResource(storeItem.icon);
  storeHolder.text_store.setText(storeItem.store );

  return view;
}
``` |
| StoreItem.java | Constructor for each store as listed in the activity DisplayStoreListingActivity. |
| activity_display_store_listing.xml | This uses a <ListView> which is populated using the image and name from list_item.xml : |
| | ```xml
<ListView
    android:id="@+id/storeList"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:gravity="center_vertical"
    android:padding="10dp" ></ListView>
``` |

list_item.xml	This contains a placeholder for each row of the store listing for image on left-hand side and store name on right-hand side of each row:

```xml
<ImageView
    android:id="@+id/image_icon"
    android:layout_width="80dp"
    android:layout_height="80dp"
    android:layout_alignParentBottom="true"
    android:layout_alignParentTop="true"
    android:layout_marginBottom="5dp"
    android:layout_marginLeft="10dp"
    android:layout_marginRight="10dp"
    android:layout_marginTop="5dp"
    android:contentDescription="@string/icon" > </ImageView>

<TextView
    android:id="@+id/text_store"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:layout_alignParentBottom="true"
    android:layout_alignParentTop="true"
    android:gravity="center_vertical|center_horizontal"
    android:padding="5dp"
    android:textSize="30sp"
    android:textStyle="bold"></TextView>
```

Table 2:14 – ListView files as used by the Store activities.

2.10.4 GLOBALVARIABLECUSTOMERID.JAVA

CustId variable is defined in app context and may then be used as a global variable. Here customer ID is used to reference CUSTOMER.TB and STORE4CUSTOMER.TB for that specific customer → customer logged in.

```java
package org.dwan.paula.lunarenterprises;

import android.app.Application;

public class GlobalVariableCustomerId extends Application {
    private int custId;
    public int getCustId() {
        return custId;
    }
    public void setCustId(int custId) {
        this.custId = custId;
    }
}
```

This is referenced in AndroidManifest.xml <Application> section :

```xml
<application
    android:name="org.dwan.paula.lunarenterprises.GlobalVariableCustomerId"
```

The global custId may then be called and set in SignInActivity.java

```java
Customerfinal GlobalVariableCustomerId globalVariableCustomerId = (GlobalVariableCustomerId)
    getApplicationContext();
customer = databaseAdapter.getCustomerUsingUserName(etUser.getText().toString());
globalVariableCustomerId.setCustId(customer.getId());
```

and then read(get) in any other activity and thus used :

```java
final GlobalVariableCustomerId globalVariableCustomerId =
    (GlobalVariableCustomerId) getApplicationContext();
int points = databaseAdapter.getStorePointsBalanceUsingStoreId
    (storeId,globalVariableCustomerId.getCustId());
```

3 TECHNOLOGIES

3.1 TECHNOLOGIES PLANNED

3.1.1 SQLITE DATABASE SOFTWARE LIBRARY OVERVIEW

SQLite is a software library that implements a self-contained, server-less, zero-configuration, transactional SQL database engine. SQLite is the most widely deployed SQL database engine in the world. The source code for SQLite is in the public domain. [1]

Each Android App has its own SQLite database and is available only to that app and no others on the device thus enabling a more secure implementation.

SQLite as other SQL based database system that also adheres to the SQL principles of :

Atomicity	All or nothing – if one part of the transaction fails then all fails (e.g.: if customer surname is invalid or not present then no data for that new customer is written to `CUSTOMER.TB`.
Consistency	For each transaction, the database is in a valid state for before and after the transaction is implemented.
Isolation	Running transactions simultaneously is the same as running one after the other – each is implementation independently of the other.
Durability	Once a transaction is completed, it is present in the database regardless of device system failures, etc.

3.1.2 ZXING OVERVIEW

ZXing ("zebra crossing") is an open-source, multi-format 1D/2D bar-code image processing library which is implemented using Java. There is functionality for other languages also. It was initially developed in Japan about 1994 for car manufacturing.

Formats supported include 1-D product, 1-D industrial and 2-D. For this project, I used :

- QR-Code → 2-D = QR-Code
- Bar-Code → 1-D industrial = Code-128

Android Components present in the latest release and those needed for **this** Android project are :

core	The core image decoding library, and test code
javase	JavaSE-specific client code
android	Android client Barcode Scanner Barcode Scanner
androidtest	Android test app, ZXing Test
android-integration	Supports integration with Barcode Scanner via Intent
android-core	Android-related code shared among android, androidtest, glass
glass	Simple Google Glass application
zxingorg	The source behind zxing.org
zxing.appspot.com	The source behind web-based barcode generator at zxing.appspot.com

There are certain permissions which are required when ZXing is incorporated into an app for bar-code and/or QR-code generation or usage. These are implemented in the AndroidManifest.xml file and are :

android.permission. CAMERA	READ → Use the device's photo camera for reading the barcode **e.g.:** *<uses-permission android:name="android.permission.CAMERA"/>*
android.permission. VIBRATE	READ / WRITE → Report that the product was successfully read / writtern
android.permission. FLASHLIGHT	READ → Better view of the barcode
android.permission. WAKE_LOCK	READ / WRITE → Maintain the application open, until the scanning operation is successfully done
android.permission. WRITE_EXTERNAL_STORAGE	READ / WRITE → Allow app to write bitmap to device for QR-code or for Bar-code.

Table 3:1 – android.permissions options available.

I implemented ZXing to generate the bar-code and/or the QR-code for the voucher or money-off coupon. ZXing may also be used to read either bar-code or QR-code using the phone's or the tablet's camera.

3.1.3 ENCRYPTION OF USER DATA

Boton	✗	http://botan.randombit.net/
		This was ruled out as this is aimed at C++ developers. Even though, it is released under a very open free BSD-2 license (see : http://botan.randombit.net/license.html for more information), it is not applicable to Android development.
SEE	✗	SQLite Encryption Extension http://www.hwaci.com/sw/sqlite/see.html
		Again, this was ruled out due to license fees – a perpetual license costs US$ 2,000.
SQLCiper		https://www.zetetic.net/sqlcipher/
		https://www.zetetic.net/sqlcipher/sqlcipher-for-android/ → how to use in Android app
		This was the one chosen as it is basically an extension to SQLite. SQLCipher also employs *256-bit AES encryption* of database files and it works on Linux and is free of charge (open source license).
SQLiteCrypt	✗	http://sqlite-crypt.com/documentation.htm
		This was ruled out as this is licensed.
		The license fee is currently US$128 ("one platform binary").
WxSQLite	✗	http://sourceforge.net/projects/wxsqlite/
		This is suited to MAC and to WOS operating systems as I used Ubuntu, it is not applicable.

Table 3:2 – encryption options evaluated

3.1.4 ENSURING SECURE LOGIN – USERS

Linux Operating System	Android devices use a Linux based operating system, this means that groups, users and also specific verification to execute files based on user and group.
Application signing	Also, the developer releases the app with a specific certificate. Once published, each Android application is given its own unique user ID, generated at installation. Anytime an app tries to do something it doesn't have permission to do, it results in a security exception and it halts.
Mandatory application sandbox	Isolate code execution from other app's on the device. This also separates app data for each app.

Secure interprocess communication	Various technologies including Linux which are used to minimize risks which may arise due to memory management errors.
	When published on the market place, the app details what permissions are needed → access to contact lists, browser history, etc.
Application-defined permissions	App's restrict access to app specific data.
user granted permissions	Users wish to restrict access and user data unless absolutely necessary. Users also wish to prevent unwanted access to system features.

Table 3:3 – Core Security features of Android development

Secure Sockets Layer (SSL) is probably the easiest and most recognizable secure login facility available today. Typically, a server is configured with a certificate containing a public key : private key pair. The client and server communicate once the server proves that it has the private key (PKI).

3.2 TECHNOLOGIES ACTUALLY USED

3.2.1 SQLITE DATABASE

SQLite is based on SQL which is explained as follows :

> Structured Query Language (SQL) is a language used to create new, access existing, query existing, and update existing relational databases. A relational database has one or more tables with a unique identifier for each row of all tables.
>
> Data is retrieved from a table or multiple tables using the main SQL commands [5] :
> - SELECT ....extracts data from a database
> - UPDATE ....updates data in a database
> - DELETE ....deletes data from a database
> - INSERT INTO ....inserts new data into a database
> - CREATE DATABASE ....creates a new database
> - ALTER DATABASE ....modifies a database
> - CREATE TABLE ....creates a new table
> - ALTER TABLE ....modifies a table
> - DROP TABLE ....deletes a table

SQLite was used as it is a standalone database system which is compact and suited to use on Android or iOS devices. There are two .java files used to define and use the SQLite database and these are explained in the section : SQLite Files.

3.2.1.1 SQL TABLE AS IMPLEMENTED – CUSTOMER.TB

CUSTOMER.TB contains customer information for every customer : name, address, date of birth (as some offers may be specific to over 18yo or to over 21yo), sign-up date, contact information and confirmation that the contact information may or may not be used for additional offers or marketing. This table also stores the customer's login name and login password and also interacts with both tables STORE.TB and with SHOP4CUSTOMER.TB. Each customer has a unique identifier in the table – the **primary key** = CUSTOMER_ID. This is an automatically incremented integer. Finally, CUSTOMER.TB contains boolean confirmation if the customer has signed up to shop1, shop2, etc. for vouchers and money-off.

CUSTOMER.TB was created using SQLite which applied the following SQL to do :

```
"CREATE TABLE " + TABLE_CUSTOMER + "(" + KEY_ID + " INTEGER PRIMARY KEY, "
+ KEY_NAME_1 + " TEXT NOT NULL, " + KEY_NAME_2 + " TEXT NOT NULL, "
+ KEY_ADDRESS_1 + " TEXT NOT NULL, " + KEY_ADDRESS_2 + " TEXT NOT NULL, "
+ KEY_ADDRESS_3 + " TEXT, " + KEY_ADDRESS_4 + " TEXT NOT NULL, " + KEY_EMAIL + " TEXT, "
+ KEY_MOBILE + " TEXT, " + KEY_EMAIL_OK + " TEXT, " + KEY_MOBILE_OK + " TEXT, "
+ KEY_THIRD_PARTY_OK + " TEXT, " + KEY_LOGIN + " TEXT NOT NULL, "
+ KEY_PASSWORD + " TEXT NOT NULL, " + KEY_CREATED_AT + " DATETIME" + ")";
```

using the call :

```
db.execSQL(CREATE_TABLE_CUSTOMER);
```

Structure is as follows and the table was pre-populated with five customers :

Table : customer.tb								
Column ID	0	1	2	3	4	5	6	7
Name	_id	name1	name2	address1	address2	address3	address4	email
Type	Integer	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL	TEXT	TEXT NOT NULL	TEXT
Default Value	null	null	null	null	null	null	null	null
PK	T	F	F	F	F	F	F	F
FK	F	F	F	F	F	F	F	F
Value 1	0	John	Ryan	12 Main St.,	Douglas	null	Cork	jryan@gmail.com
Value 2	1	Amy	Collins	123 Rock Ave,	Cork	null	Cork	acollins@gmail.com
Value 3	2	Emily	Blackwell	555 Roswell Ave.	Blessington	null	Wicklow	emily@gmail.com
Value 4	3	Max	Roberts	25 Second St.,	Naas Rd.,	Blessington	Wicklow	mroberts@gmail.com
Value 5	4	Cathy	Jones	22 O'Connell St	Dublin 1	null	Dublin 1	jones123@gmail.com

Column ID	8	9	10	11	12	13	14
Name	mobile	emailOk	mobileOk	thirdPartyOk	nameLogin	passwordLogin	createdAt
Type	TEXT	TEXT	TEXT	TEXT	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL
Default Value	null	null	null	null	null	null	null
PK	F	F	F	F	F	F	F
FK	F	F	F	F	F	F	F
Value 1	087-7766321	1	1	1	jryan	password	getCurrentDate
Value 2	085-7654321	1	0	0	acollins	password	getCurrentDate
Value 3	085-7654000	0	1	0	eblackwell	password	getCurrentDate
Value 4	086-9988771	0	0	1	robertsm	password	getCurrentDate
Value 5	null	0	0	0	jonesc	password	getCurrentDate

3.2.1.2   SQL TABLE AS IMPLEMENTED – STORE.TB

STORE.TB contains information on each shop which has signed up the scheme : name, logo, address, contact number, contact email, name of main contact, name of backup contact, date shop joined the scheme and date shop left scheme. Each shop has a unique identifier in the table – the ***primary key*** = STORE_ID. This is an automatically increment integer. If the shop leaves Lunar Stores then no more additional points may be collected after this date and earlier points no longer apply (to that store).

STORE.TB was created using SQLite as follows :

```
"CREATE TABLE " + TABLE_STORE + "(" + KEY_ID + " INTEGER PRIMARY KEY, "
+ KEY_NAME + " TEXT NOT NULL, " + KEY_LOGO + " TEXT NOT NULL, "
+ KEY_CONTACT_NAME + " TEXT NOT NULL, " + KEY_CONTACT_EMAIL + " TEXT NOT NULL, "
+ KEY_CONTACT_PHONE + " TEXT NOT NULL, " + KEY_CREATED_AT + " DATETIME" + ")";
```

using the call :

```
db.execSQL(CREATE_TABLE_STORE);
```

Structure is as follows and the table was pre-populated with five customers :

Table : store.tb							
Column ID	0	1	2	3	4	5	6
Name	_id	name	logo	contactName	contactEmail	contactNumber	createdAt
Type	Integer	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL	TEXT NOT NULL
Default Value	null	null	null	null	null	null	null
PK	T	F	F	F	F	F	F
FK	F	F	F	F	F	F	F
Value 1	0	Alpha Stores	logo_alpha	Joe Walshe	alphastores@gmail.com	085-1122345	getCurrentDate
Value 2	1	Beta Stores	logo_beta	Peter Roberts	betastores@gmail.com	087-2323543	getCurrentDate
Value 3	2	Orange Stores	logo_orange	Emma Williams	info@orange-stores.com	085-5551234	getCurrentDate
Value 4	3	$$$-Stores	logo_dollar	Trixie McRoy	info@dollar-stores.com	086-1234555	getCurrentDate
Value 5	4	€€€-Stores	logo_euro	Josh Williamson	info@euro-stores.com	085-1221343	getCurrentDate

3.2.1.3 SQL TABLE AS IMPLEMENTED – SHOP4CUSTOMER.TB

`SHOP4CUSTOMER.TB` contains a direct 1-1 link between a shop in `STORE.TB` and a customer in `CUSTOMER.TB` using the **primary keys** of `CUSTOMER_ID` and `STORE_ID` respectively. `SHOP4CUSTOMER.TB` has a **primary key** = `SHOP4_ID` and again, this is an automatically increment integer.

`STOREFORCUSTOMER.TB` was created using SQLite as follows :

```
"CREATE TABLE " + TABLE_SHOP_FOR_CUSTOMER + "(" + KEY_ID + " INTEGER PRIMARY KEY, "
+ KEY_STORE_ID + " INTEGER, " + KEY_CUSTOMER_ID + " INTEGER, "
+ KEY_POINTS_BALANCE + " INTEGER, " + KEY_CREATED_AT + " DATETIME" + ")";
```

using the call :

```
db.execSQL(CREATE_TABLE_SHOP_FOR_CUSTOMER);
```

Structure is as follows and the table was pre-populated with five customers :

Table : store4customer.tb							Customer	Store
Column ID	0	1	2	3	4			
Name	_id	customerId	StoreId	StorePoints	createdAt			
Type	Integer	Integer	Integer	Integer	TEXT NOT NULL			
Default Value	null	null	null	null	null			
PK	T	F	F	F	F			
FK	F	customer.tb : _id	store.tb : _id	F	F		Customer	Store
Value 1	0	1	1	100	getCurrentDate		jryan	Alpha Stores
Value 2	1	2	1	200	getCurrentDate		acollins	Alpha Stores
Value 3	2	3	2	300	getCurrentDate		eblackwell	Beta Stores
Value 4	3	4	2	400	getCurrentDate		robertsm	Beta Stores
Value 5	4	5	4	500	getCurrentDate		jonesc	Orange Stores
Value 6	5	1	2	600	getCurrentDate		jryan	Orange Stores
Value 7	6	2	3	700	getCurrentDate		acollins	$$$-Stores
Value 8	7	3	4	800	getCurrentDate		eblackwell	$$$-Stores
Value 9	8	4	5	900	getCurrentDate		robertsm	€€€-Stores
Value 10	9	5	5	1000	getCurrentDate		jonesc	€€€-Stores

When a customer uses the app, all rows in the table STORE4CUSTOMER.TB containing that CUSTOMER_ID and a valid STORE_ID indicate that store is available for use by that customer. All other stores are available for current or future selection. If another store is activated by the customer then a new row is added to the table and the customer may start collecting points having an initial value of 0 (nil) points. This balance is increased if the customer shops in that store or decreased if the customer uses available points to purchase a % or money-off voucher.

3.2.2 ZXING QR-CODE & BAR-CODE GENERATION

Also, ZXing works on Android via Intents or by referencing the ZXing library. Intents are easier to implement but the customer must have ZXing preinstalled on his/her device. This involved the customer agreeing to a 3rd party product and additional download before he/she even gets to use **Lunar Stores.** Alternatively, and this was the method implemented for this project.

In order to use ZXing libreary, add **this** line to the dependencies section of the gradle.build file (ZXing is present in the Maven Public Repositories and may be retrieved from there) :

```
dependencies {
  compile fileTree(dir: 'libs', include: ['*.jar'])
  compile 'com.android.support:appcompat-v7:21.0.3'
  compile 'com.google.zxing:core:3.1.0'
}
```

and then import the library in the usual fashion in the activity :

```
import com.google.zxing
```

There are minor differences between QR code and Bar-code Generation, mainly in image size, writer/reader, depending on where the *-code is a voucher generated for use in a store or is a code being read to increate customer points. Both, however are black and white so minimal RGB is required.

3.2.2.1   ZXING QR-CODE GENERATION

QR-Code uses *com.google.zxing.Writer* to create a new *QRCodeWriter(),* The *BarCodeFormat* is *QR_CODE* and of course the resulting Bitmap is square *150x150 pixels*.

Creation of the Bitmap is the same as that for the Bar-Code pixels are generated for x,y co-ordinates for the full square and each pixel is black or white. The resulting bitmap is then displayed to the user for use.

ARGB_8888 is recommended for the Config of the resulting bitmap but as this is a Black & White image, pixelation will not be lost if *RGB_565* is used instead.

3.2.2.2   ZXING BAR-CODE GENERATION

Bar-Code uses *com.google.zxing.MultiFormatWriter* to create a new MultiFormat*Writer(),* The *BarCodeFormat* is *CODE_128* and of course the resulting Bitmap is rectangular *180x40 pixels*.

3.2.3   ENCRYPTION OF USER DATA

Due to the reasons detailed in section Encryption of User Data, I choose to use SQLCipher to encrypt user data in the SQLite database.

Advantages :	1. Strong encryption → 256-bit Advanced Encryption Standard (AES), Rijndael algorithm
	2. Open-source so thus has advantage of many developers working on improvements, as well as company developers
	3. Works in tandem with standard Android database functions
	4. Mature technology
Disadvantages :	1. APK will be much larger in size
	2. Database access (RW) will be slower as all data is encrypted, thus the app will be slower. Will this impact user satisfaction or is encryption perceived as worth it? Expect 10%-30% reduction depending on app size and number of database read|write. If speed is a factor, then there is always AES 128-bit and AES 192-bit.
	3. The encryption key will need to be retained safely. Also, is the same key used for all instances of the app or is one created per device?
	4. The USA or some other countries are less inclined to support strong encryption than is Ireland.

Using SQLCipher into an Android Studio project is relatively painless. Instructions follow :

Integration into Android Studio	1. Download SQLCipher (ZIP format) from zetetic.net or clone from from git :
| | ```
https://www.zetetic.net/sqlcipher/opensource/
git clone https://github.com/sqlcipher/androiddatabasesqlcipher.git
``` |
| | 2. In app/src/main directory, create two sub-directories as follows : |
| | ```
app/src/main/jniLibs
app/src/main/assets
``` |
| | 3. Extract contents of /assets   directory (including all sub-directories and contents) from |
| | ```
sqlcipher-for-android-community-v3.3.0.zip  to app/src/main/assets.
``` |
	4. Extract contents of */libs* directory (including all sub-directories and contents) from *sqlcipher-for-android-community-v3.3.0.zip* to *app/src/main/jniLibs*.
	5. Also add : *guava-r09.jar* and *commons-codec.jar* to *app/src/main/jniLibs* – these do not seem to form part of the .zip file and will need to be searched for online.
	6. Amend gradle.build to refer to SQLCipher, by adding the following line :
| | ```
compile fileTree (dir: 'libs', include: ['*.jar'])
``` |

Replace SQLite with SQLCipher	1. Replace generic SQLite imports with SQLCipher imports :

	``
	// WAS
	import android.database.Curson;
	import android.database.SQLException;
	import android.database.sqlite.SQLiteDatabase;
	// NOW
	import net.sqlciper.Curson;
	import net.sqlciper.SQLException;
	import net.sqlciper.database.SQLiteDatabase;
	``

	2. 2. Amend all calls to open/create database :

	``
	// WAS
	getWritableDatabase();
	// NOW
	getWritableDatabase('my_sequre_key');
	``

	3. Initialize SQLCipher (first command to run) :
	``` import net.sqlciper.database.SQLiteDatabase SQLiteDatabase.loadLibs(context); ```

3.2.4 ENSURING SECURE LOGIN – USERS (BASIC)

Unique user name and password was required for each user. If a user created a second account with the same contact details, he/she was permitted to do so. For future iterations, it would be best to confirm that this was completed by email or SMS.

Also minimum requirements for user login name length and also password are required. I don't this that applying more stringent sign-in requirements, for example : alpha-numeric password with no proper words allowed or requiring users to sign-in in prove to would be viable. This is a consumer app, one that is designed to be used in a public venue – hopefully frequently. It will not be practical to apply as strong safe-guards as Banks.

3.2.5 ENSURING SECURE LOGIN – USERS (ANDROID DEVELOPMENT)

Some of the areas raised in section Ensuring Secure Login – Users for consideration are detailed as follows :

Application-defined permissions	Content providers may be restricted to the app or share information with other apps. Restrict access to the app using one line in the AndroidManifes.xml file :
	``` android:exported="false" ```
	Be careful if your app permits use of external storage → only store non-sensitive information (e.g.: general information but not database information or login details).
User granted permissions	This may be set using (i) System properties from ACCESS_CHECKING_PROPERTIES to WRITE_VOICEMAIL or (ii) <permission> option :

	``
	<permission
	  android:description="string resource"
	  android:icon="drawable resource"
	  android:label="string resource"
	  android:name="string"
	  android:permissionGroup="string"
	  android:protectionLevel=
	    ["normal"|"dangerous"|"signature"|"signatureOrSystem"] />
	``

	Both are set in the AndroidManifest.xml file
Mandatory application sandbox	This is a standalone app and the executable code and the local database are independent of any other app's on the device. No other app should have access to the data Also once the user logs in the login name	password pairing is no longer used, the customer id is used instead. This is unique and non-transferable to another person. It also is numeric and has no relation to the customer.

3.3   WHAT I WOULD HAVE USED INSTEAD!

I don't believe I would have used different technologies. However, I would have applied the integration of each differently. As I was unfamiliar with them, I firstly worked through a standalone example of each (SQLite → basic sign-in to app), SQLCiper, and ZXing. Then I applied each to the app → Lunar Stores. This led to quite a few problems such that SQLCiper is not yet integrated. That said, from previous experience it takes a few lines and about 30 minutes to do so. While I did not notice any decay in performance with SQLCiper and SQLite in the basic sign-in app, I would expect larger app's or those with a higher volume of database access to take more time to complete tasks.

There are other database options available but SQLite is one which seems to be preferred for Android development due to its low impact on memory during execution and saving. However, I found it somewhat lacking (no Foreign Keys, Triggers had to be manually implemented). This reduced ease of use for non-SQL experienced persons and also increases the overheads on maintenance of a live system.

SQLCipher is designed to work with SQLite and is readily integrated into new or existing code. However, there are limited examples of it in use in a complex environment. Lunar Stores is more proof-of-concept as there is no database integration to the server end. This could be completed at set times of the day or on request. JSON over SSL would probably be the best for performance and for security for this.

4   CHALLENGING / INTERESTING FEATURES

4.1   WHAT I THOUGHT WOULD BE CHALLENGING / INTERESTING?

SQL / SQLite	I expected SQL / SQLite implementation to be of particular interest. Previously, I would have worked on SQL databases in Linux and it is only through this project that I realized how much knowledge I had lost.
ZXing	I expected this to be somewhat difficult to implement as most of the examples and documentation cover reading of QR-Codes and Bar-Codes and not generation.
Encryption	Encryption was I thought going to be the most complex to implement.
Security	There is so much material and guidelines available that I found some contradictory and other information a little too much for such a small app. I am sure that commercially all would need to be considered (see :).

4.2   IN THE END – WHAT WAS ?

SQL / SQLite	SQLite implementation was as interesting as I had expected it to be.
ZXing	The actual implementation was reasonably okay, however whether this will work with shop bar-code / QR-code readers is not something I have tested so I don't know if the slight glare on some phone screens would impact use. It may be necessary to dim the screen before hand and reset it after the bar-code / QR-code is read t point of sale.
Encryption	In the end, SQLCiper was quite easy to apply and works well for small app's or less complex database reliant app's.
Security	Not as difficult as I had expected.
Other	Small things, like sourcing logo's for the stores. In the end, I made my own.

4.3   IF I HAD MY TIME OVER – WOULD I DO THIS PROJECT?

Yes but I would have been more specific on what I would accomplish in the time available. I would also have done more initial research into the technologies I thought appropriate. I also think that this has more commercial suitability that I had originally envisaged and thus would have been better completed by a team, thus ensuring that more than one viewpoint was taken into consideration. I would also have partnered with a retail outlet for testing purposes, just to make sure it works as planned. Finally, I would survey shoppers in various age-groups to see exactly what each needs. As what I have designed may not be what the market wants.

There are similar app's available on the market but there seems to negative feeling towards **(i)** complexity and **(ii)** privacy. Android users seem concerned that companies are installing and upgrading app's without users registering for that app. Even if that app is dormant, upgrades are completed. For example; the Samsung app *'Beaming Service for Samsung'*. This goes against privacy claims that many company Android app suppliers advocate and users request.

> *we are not Apple or Google, we will not retain your data without your permission* (paraphrased)

This is the main reason that I design a registration activity as part of this app – if the user does not agree to the T&C's or if he/she de-registers then the app is disabled on his/her Android device. For future implementation, perhaps on de-registration the user can be offered an option to delete the app from the device, similarly this option could also be made available in the T&C activity.

This app if offered commercially would require more back-end support and implementation than I have provided. This is due to Data Protection and security concerns.

It may also be possible to enable a user to apply a bespoke background perhaps sponsoring a local organization or team (10% of points raised by the customer would go to that organization). This could be advertised by the customer through a background or color schema in the teams / schools colors.

3-Level SQLite was applied which would make it relatively easy to separate the database helper and adapter into separate package, this would be advisable for a commercial app. In this implementation, I just created separate packages for customer, store, database, etc. This could be amended with the addition Design Pattern Factories for addition of new users →

- multiple simultaneously – how handled?
- who takes priority if a duplicate login name
- complexity of password required – I would expect a lot of people would use say *'Passw0rd',* date of birth or the name of a local store for ease of re-call).

Ref.	Information	How used? / What for?
[1]	SQLite database software library https://www.sqlite.org/	Store customer and store information in separate database (.db) files.
[2]	• SQLite tutorials http://www.tutorialspoint.com/sqlite/ http://www.vogella.com/tutorials/AndroidSQLite/article.html • SQLite – multiple tables http://www.androidhive.info/2013/09/android-sqlite-database-with-multiple-tables/ • SQLite – ListView http://www.mysamplecode.com/2012/07/android-listview-cursoradapter-sqlite.html	Introduction to applying SQLite (overview, multiple tables and listview)
[3]	SQLite training https://www.sqlite.org/autoinc.html	Introduction to applying SQLite to project implementation.
[4]	Bar-code / QR-code Generation https://github.com/zxing/ http://codeisland.org/2013/generating-qr-codes-with-zxing/	Code for ZXing Training for ZXing *(not really well documented for generation on device)*
[5]	SQL http://www.w3schools.com/sql/default.asp	Introduction to SQL commands and usage.
[6]	ListView – icon & text used structure from Assignment 2	ListView of stores for which points are collected or add a store to the list and start collecting points for it.
[7]	Tick-box / Check-box http://examples.javacodegeeks.com/android/core/ui/checkbox-ui/android-checkbox-example/	Tutorial - allow SMS, email & 3rd party contact customer
[8]	SQLCipher https://www.zetetic.net/sqlcipher/ https://www.zetetic.net/sqlcipher/sqlcipher-for-android/	Source material and training for SQLCipher (encryption for SQLite).
[9]	Android security https://developer.android.com/training/articles/security-tips.html http://developer.android.com/training/articles/security-ssl.html	Build in security features and design advice.
[10]	Licenses : 1. SQLCiper → BSD license https://www.zetetic.net/sqlcipher/license/ http://www.apache.org/licenses/LICENSE-2.0 http://source.icu-project.org/repos/icu/icu/trunk/license.html 2. SQLite → https://www.sqlite.org/copyright.html 3. ZXing → http://www.apache.org/licenses/LICENSE-2.0.html	These need to be acknowledged for inclusion / use in this app.