Imperial College London

# RECEIPTBOOK FINAL REPORT

## SECOND YEAR PROJECT

**GROUP 6**


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# 2 ABSTRACT

The purpose of our project was to provide people with a digital form of their receipts to reduce paper usage. This idea developed further to use the wide range of information available to the user from their receipts to aid the user with budgeting and saving money. This was especially relevant to students, as for many students this is the first time they have to manage their money by themselves.

After careful consideration, it was decided to implement a smart phone application that would communicate with an NFC module on a contactless payment point to collect the user's receipt. The development software 'Android Studio' was used to implement the application. It was also necessary to adapt how the Point-of-Sale system generated a receipt, so a Raspberry Pi was used to demonstrate how this would be done.

The result is a mobile application that collects a digital format of the customers receipt. This information is then processed to provide the user a breakdown of their spending including current total spending for the month; a projection for the total spend by the end of the month; as well as categorised spending. A budget is set for each category by the user and is used to indicate over or under spending.

The product has been beta-tested with a few focus groups and there was great positive feedback from the focus groups. Based on the feedback, the implementation of the product is feasible. Future work to market the product is required. Contacting large-scale vendors and convincing them to implement the product will be the biggest hurdle to come. The product still requires more development to be able to implement it in iPhones and not just Android phones. More data security and storage options need to be included to actually ensure reliability of product. The results from focus groups have outlined the need for such product but implementation will still take time as marketing of product has yet to begin and development is still in process.

# 3 INTRODUCTION

Keeping track of receipts can be cumbersome and it is often annoying to have a wallet full of paper. It is very easy to misplace important receipts but very hard to keep track of itemised spending. The first cash registers were first invented by James Ritty and John Birch (patented in 1878) (1), these were all entirely mechanical cash registers and did not produce receipts as of yet. It was not until the company was sold to John H. Patterson is when the first receipt was invented. John H. Patterson decided to add paper rolls for record sales transactions, to prevent fraud and kept a track of sales. (2) More than a hundred years later and paper receipts are still used to record transactions.

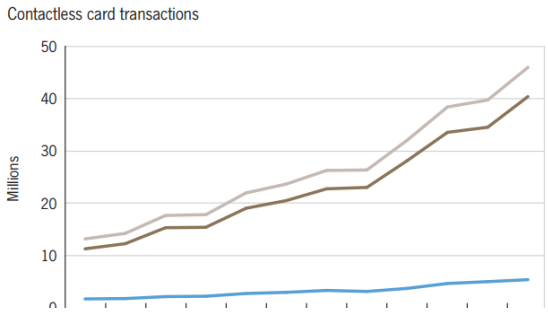


*Figure 1 - A graph of contactless payment transactions in 2015 (80)*

In the United Kingdom seven out of ten people own a smart phone, furthermore in the 16-30 age group, 87% own a smart phone (3). This powerful technology has evolved rapidly since its inception. (4) Many of these pocket-sized devices contain NFC readers and writers. This technology can be used to transfer data wirelessly between points. It is an easy and fast way to transfer data as it does not require 'pairing' or passwords to transfer data. The use of NFC is already implemented in contactless payment and has since became increasingly popular, as you can see the increasing trend for 2014 in Figure 1.

## 3.1 BACKGROUND

The problem at hand can be broken down into three sections: carrying and collecting receipts is annoying; paper uses a lot of resources, including water, wood and oil, in production; personalised and itemised information about the customer's spending is not easily accessible to the customer.

Looking only at card transactions, there were '13 billion transactions' in 2014 in the UK alone. Assuming about 80% of these transactions are in store transactions producing paper receipts, roughly 10 billion receipts are printed without even taking cash transactions in to account. (5) (6) This is a staggering amount – approximately 28 million per day. This equates to a lot of paper in the consumer's pockets, or more often than not the bin. This can be observed easily at many self-checkout Point-of-Sale in many supermarkets, with bins full of discarded receipts.

On average 660,000 tonnes of paper is used each year to make receipts which equates to roughly around 250 million gallons of oil , 10 million trees and 1 billion gallons of water being consumed and this is only in the USA alone. (7) (8) These are colossal figures and just shows how much of a carbon footprint paper receipt. Around 907.185kg of carbon is stored in the average sycamore tree (9), whilst not all of the carbon translates into forming carbon di-oxide and carbon monoxide (which are both greenhouse gases) and contributing to global warming, a large proportion is. It is easy to envision how cutting 10 million trees could result in large amounts of greenhouse gasses being released.

Deforestation of the amazon to make pulp (paper) has already caused several species to become extinct, as their habitats are destroyed causing wildlife to migrate and adapt or die out. A team of researchers predicted that for every 31 by 31 mile block of forest would result in 16 species to be extinct by 2050. (10) This could possibly set back the biodiversity of forests and affect food changes.

Furthermore, very old forests also known as virgin forests have been the victim of deforestation as well. Virgin forests hold a vast amount undiscovered wildlife resulting in several species to become extinct before even being discovered.

Another issue include that young adults, mainly students face many financial difficulties. Many seek counselling requesting help in regards to managing money and it's the case in some situations that financial issues causes massive amount of stress, anxiety and depression for students alongside the heavy workload provided by university.

Students at university have a tough time and always face problems whether its anxiety issues, depression, stress, not studying for an exam the very next morning which more people do then you'd think, etc. (11) These are all problems many student face but the most notorious of them all is that students are riddled with financial issues and with record number of students attending university this problem with only increase. (12) It was not until recently tuition fees increased from £3,000 to £9,000 whilst oversea students pay remarkable sums of around £27,000+, these are big figures for mere teenagers starting there campus life away from home. Stress is the collar of these finical issues and an increasing number of people are requesting counselling due to not being able to manage their money. Students becoming independent with no experience in handling and managing money either results in a float or sink financial status for the student causing colossal amounts of stress. This is where the e-receipt comes in and provides aid.

Large companies like Tesco have access to a lot of spending habits of the public through things like 'Tesco Club Card', which gives them the opportunity to target the customers with personalised deals – ultimately getting the customer to spend more money. However, there is no obvious way for the customer to view their personal spending. It can be argued that advances in online banking have allowed the public to keep better track of their finances, however online banking does not offer an itemised break down of transactions. So for example, £50 spend at Sainsbury's could be entirely for food, or drinks, or even electrical items. It is therefore hard for the customer to know in which areas they are over spending. This is especially relevant for university students, as for the majority it will be their first time they have to manage their own finances. It can be difficult to be responsible with money when you do not know exactly where the money is going.

# 4 Design Criteria

After careful consideration of the problems the project needed to tackle, a design criterion was developed. This has been adapted from the interim report as a result of the feedback the project received. Additionally the PDS has also been updated.

1. A receipt must be available to the customer in a digital form.
2. Paper should not be used, in order to reduce paper consumption.
3. The receipt has to have the key information of the customers' transaction, including individual items and their prices.
4. The information from the receipts should be used to make users' more aware of their spending tends and habits, and clearly illustrate these in an understandable manner. This should allow them to improve money management and financial self-efficacy.

## 4.1 Problem Definition Specification

From these five key design criteria, the problem design specification (PDS) was developed in the first term. At the start of spring term the PDS was reviewed and updated, in order to give a more general look at what

was needed for the project's success. This gave a more in depth view of what the project result needed to achieve, and what it was bound by. The PSD can be found in the appendix. Furthermore, the most important points of the PDS were selected as a focus for the outcome. The most important aspects were:

Performance – The performance of the system is vital to its' success and integration into society.

Competition – The product needs to provide a new service for users, or out-perform similar ideas.

Target Product Cost – The cost of implementation needs to be low, for the vendor especially as this will encourage implementation.

Customer – Throughout the design processes the customer's needs and their motivations to adopt new technology. The vendor also needs to be viewed as a customer. This links to the feasibility.

Aesthetics, Appearance and Finish – The final product needs to look very professional, to instil a sense of trust in its users, as receipts are linked to paying and personal information. User experience can also be greatly increased by appropriate colouring coding and clearly showing navigation tabs and buttons.

Quality and Reliability – This aspect was chosen because it is key to ensure that the system is entirely reliable, as eventually it would replace all paper receipts and if it were to fail, the customer would not receive their receipt causing serious complications from the vendors and customers point of view.

Testing – The testing of the system was also considered very important, as bugs and errors in the system would have to be found before it could be implemented in a real shop situation. It would also be very important for development and debugging in the prototyping phase.

It was felt that focusing on these areas would provide the best result for the customer. As this project is large scale success is dependent on the adoption of the system into the general population, and for it to become a normalised, daily occurrence. From these key design criteria and the PDS points chosen, several concept designs evolved.

# 5 Concept Designs

The current problem with the widespread use of receipts could be solved by replacing the system with an electronic data transfer and storage system. Initially, the following concepts were considered: e-mail, wireless communication and flash memory.

## 5.1 E-mail Data Transfer

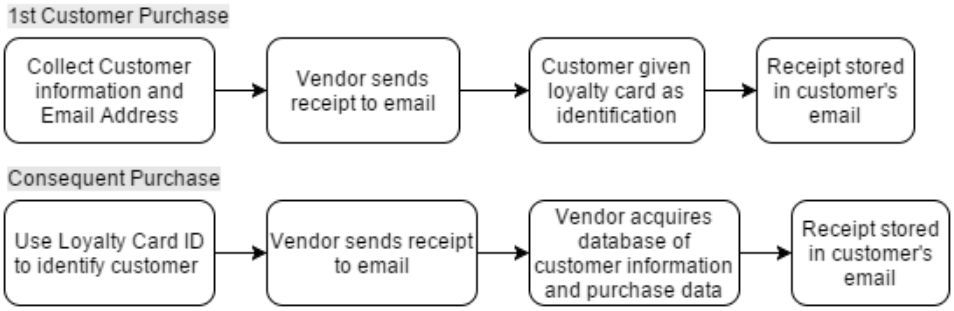


*Figure 2-Flow diagram showing the email data transfer process*

The system shown above can be incorporated within loyalty cards, which allows for easier implementation. However, email based receipt systems are already available in UK. Companies such as Argos, Monsoon and Accessorise have already implemented an e-receipt system although not within loyalty cards. (13)

There is also a necessity for customers to share personal data, which makes customer's personal information more susceptible to breaches as seen from the information breach that occurred at Target. (14) Albeit, the customer data can be used to improve sales through product recommendation as seen from the Argos case study where sales improved by 25% with the help of digital receipt implementation. (13) This concept also provides vendors with the liberty of sending customers promotional emails and if misused can be detrimental to vendor sales and product implementation. (15)

When evaluating this against the Product Design Specification, it is worthy to note that this solution uses existing infrastructure, such as emails and existing storage methods such as vendor's internal database, thus making it easier to implement. (16) The lack of external product or additional software reduces the overall product cost. The concept uses an existing system such as e-mails, making it reliable. (17) However, the idea has already been established in various stores, which increases competition and thus reduces probability of product implementation. (18) An additional system will be required to implement budgeting functionalities such as a webpage or application making budgeting information less readily accessible, thus reducing quality of product. (19)

## 5.2 Wireless Communication Technologies

Concept design ideas utilising wireless data transfer technologies, namely Wi-Fi, cellular networks and NFC will be discussed in this section.

### 5.2.1 Static NFC Tags

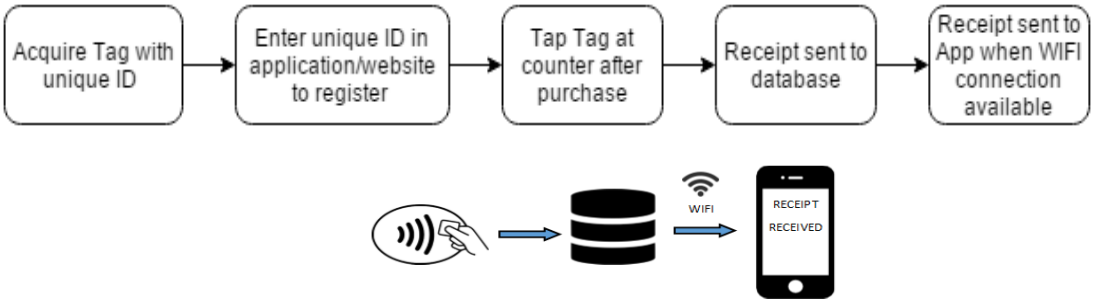


*Figure 3-Flow diagram showing the transfer of data*

This concept uses near-field communication ('NFC') tags with a unique identifier to identify the customer and transmits the receipt data to the customer via an internet connection, which is provided by Wi-Fi or over the cellular network. This requires an additional database to store temporarily the data before retransmitting the receipt information. The idea is relatively new and is similar to a trial implementation seen in the United States. (20) The concept also requires an additional NFC transceiver at the point-of-sale to be installed, which on average costs £30 per installation. (20) However, this is still more economical than current popular thermal receipt printers, which retail at £200 per installation and additional cost is required to replenish the thermal paper. (21) The need to install and adapt to a new system will increase difficulties in terms of implementation.

NFC tags will also need to be produced in mass quantities at a cost of approximately £1 each (22). This reduces cost effectiveness of the concept. An external datacentre is also necessary to hold the receipt data on behalf of the customers. This is so that customers do not require a working internet connection at time of

purchase to use the system. The feasibility of a datacentre is questioned due to its high running cost, as using datacentre services will cost a minimum of £420 per month. (23)

An important product specification point is consider is the ease of use, quality and reliability of the system. This concept ensures that budgeting information is readily accessible on the application. It also ensures that the product is unique as it has yet to be implemented widely in UK stores. (24) By using pre-existing well-tested technologies, such as Wi-Fi and NFC, a good reliability would be ensured. (25) However, high initial cost would dampen the progress of development and testing. This also makes implementation harder as vendors will be charged more for the service, thus inconveniencing a large group of the product's customers, the vendors. (23)

### 5.2.2 NFC Peer-to-Peer Communication

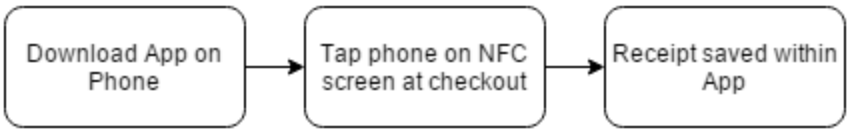


*Figure 4- Sequence of customer actions to retrieve receipts*

This concept also makes use of NFC, as discussed before in the 'Static NFC Tag' concept; however, it does not require a database for storage or WIFI for data transfer. It employs the storage within the customer's phone to store data, uses internal database within the user's phone and relies only on NFC to transfer the data.

However, this concept requires a smartphone with NFC functionality. This is available on many Android phones and newer generations of iPhones. (26) The only additional equipment required will be an additional NFC transceiver at the point-of-sale system, which can be added to most of the today's popular system through USB. (27) As discussed for the 'Static NFC Tag' concept, by not warranting the use of a datacentre, this idea is more cost effective, when compared to other ideas as well as traditional paper receipts; however, the lack of centralisation of data increases the difficulty in its implementation and management. (21)

This design simplifies implementation for the customers as they only need their phone and the receipt will be transferred to the phone as a message in the NFC Forum data format ('NDEF') and stored on the smartphone. (28) This ensures that security and storage of data is handled by the customers themselves, as the data do not pass through any third parties, so it is less vulnerable to man-in-the-middle attacks, making it safer. (29)

Similar to the previous concept, this concept uses reliable and pre-existing methods. It also allows for readily accessible and interactive budgeting increasing the overall quality of the product. (30) The performance is entirely dependent on the way it is developed as no external sources, such as external cloud datacentre services, are used. This makes it easier to ensure the product is high performing. The lower product cost also enables for cheaper testing, development and implementation. (31) The ease of implementation, is however, impeded by the fact that not all phones have NFC functionality and that the vendors will still have to pay for an additional point-of-sale. (32)

## 5.3 FLASH MEMORY

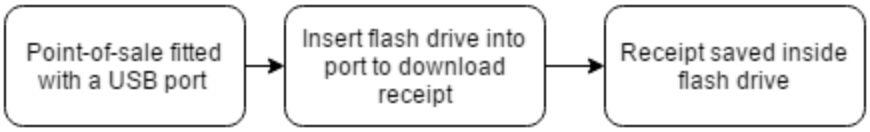


*Figure 5- Sequence of actions to implement the Flash Memory system*

This concept requires a USB expansion port fitted with the existing point-of-sale systems. The USB expansion port retails at a cost of £10.99. (22) This implementation is cheaper than a NFC transceiver. However, this system requires customers to purchase and always keep a flash drive in their possession, which comes at a cost of around £10. (33) The receipt files will also need to be isolated and sent to a processing device, from which customers can acquire their receipts. The receipt data will have to be erased regularly, after each receipt data acquisition, to prevent one from viewing another person's receipts to maintain customer confidentiality. (34)

Customers will also not be able to view the receipts at the point of purchase but only by using a separate device with a USB port to review the data. Security and storage is solely handled by the customer. This can be easily compromised if the customer physically misplaces the flash drive or does not encrypt the data with the use of a password on their flash drives. (35) (36) This concept puts the entire responsibility of looking after the safety and security of the receipt data on the customer, who may be reluctant to do so and thus reducing the use of the system.

This concept has a low product cost, however, budgeting information cannot be carried out easily as all information is immediately transferred to the consumer. The user will have to access another application that will process the information, thus reducing the quality of the service. (37) Additionally, the product will be harder to implement, as users will have to be required to purchase and carry around flash drives, which are becoming more and more unpopular. (38) Most of the data security has to be handled by the user, making the reliability of data safety low. (36)

# 6 CONCEPT SELECTION

After considering each concept design against the selected PDS, each design was scored in a matrix to better inform the concept selection. At this point, the aesthetics and the testing of the system will not be taken into account, as the concept selected would need further development to specify these areas.

*Table 1- Concept Comparison of Critical PDS Criteria*

| PDS feature | Importance Score | E-mails | NFC Tag and WIFI | NDEF message | Flash Drive |
|---|---|---|---|---|---|
| Performance | 9 | 3 | 7 | 8 | 4 |
| Competition | 7 | 2 | 4 | 5 | 6 |
| Target Product Cost | 8 | 7 | 4 | 8 | 6 |
| Customer | 10 | 3 | 8 | 9 | 2 |
| Aesthetics, Appearance and Finish | N/A | - | - | - | - |
| Quality and Reliability | 10 | 7 | 8 | 8 | 6 |
| Testing | N/A | - | - | - | - |
| TOTAL POINTS | | 22 | 31 | 38 | 24 |

A closer inspection of the two highest scoring concepts was required, 'NFC Tag and WIFI' and 'NDEF Message'. One of the original design criteria was to reduce paper usage, to have a positive effect on the environment however it has to be taken into consideration the effect on the environment in 'NFC Tag and WIFI' concept. It proposes the use of external servers to store the users' receipts, which can consume large amounts of energy. Therefore the concept has less positive affect on the environment compare to the 'NDEF Message' concept, which stores the receipts on the phone. This also gives arise to consideration of the 'Customer' PDS point. The storage of the receipts on the customers' phone will require memory space on the mobile phone, which is often in short supply, so it would be necessary for the receipt storage to be properly managed.

As both proposals implement an application all the key information – as specified in the original design criteria – will be easily accessible to the user along with valuable spending information and budgeting statistics.

Overall, the group decided that as the purpose of this project was to make a contribution to social or environmental improvement, the 'NDEF Message' concept would be selected – with a NFC point and phone application. It was also taken into consideration that, as storage capacities in smart phones continue to increase the issue of receipt storage mentioned above, will hinder the users' phone less.

Moving forward with this concept, additional criteria where included to better meet the design criteria and PDS with relevance to this specific idea in its development: the aesthetics and technological limitations. The aesthetics of the application have to be of a high standard to be pleasing to the customer when used. Additionally the functionality of the application needs to coincide with common application structures so the user will be able to learn quickly how this application works. The amount of memory to be used for storage of receipts has to be limited, in order to not compromise the rest of the functionalities on the phone (such as photo storage).

# 7 RESEARCH

## 7.1 MARKET RESEARCH

To ensure the originality and innovation of this project, it was felt important to conduct some market research. Forms of digital receipts were a key area of research.

Research into email receipts showed large companies, like Argos and Apple, have already implemented this system. (39) The customer provides an email address at the till after paying, and then a digital copy of their receipt is sent. Their implementation was well received, "Customers love it because they feel reassured that they have a record of purchases without cluttering up their wallets, and colleagues appreciate the benefits which enable them to provide an even more convenient service to customers." On closer inspection, the system in place is extremely similar to the first concept design.

It is encouraging for the project that digital forms of receipts have been received so well, "Emailed receipts sent by eReceipts currently achieve open rates in excess of 70%". (40) The company eReceipts uses a card to phone system. At the POS, one must give their eReceipts card at the till for scanning. After being scanned the receipt will be directly sent to the account registered the account of that card. Viewing of the receipts can be done via the mobile application. The details that will be stored are proof of purchase, details of purchase along with any product warranty there maybe is stored. (41)

Another company based in the US, named Proximiant that provides digitised receipts, was included in the market research. This system uses an application that sends receipts directly to your phone wherever you shop. They use the tap and store approach, where one has to tap their phone on the scanner and the receipt is sent directly to the phone application. Alternatively the scan and store approach can be used (20). This company offers additional features compared to eReceipts, like coupons depending on geographical location.

All of these systems provide the user with a digital receipt; however, none offer a service of analysing the spending data for the customer. Looking specifically at budgeting phone applications, many require manual input of expenses, for example a mobile application named HomeBudget (42). This requires the user to create, edit and delete expenses and then provides them with options to set budgets, attach images of receipts and view reports of spending. The major downfall with this system is the time and effort required by the user to keep track of all of their spending.

## 7.2 SURVEY

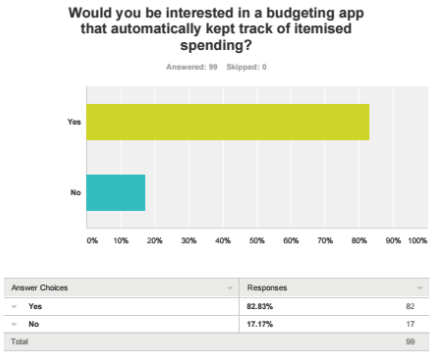


*Figure 6 - Question 2 and its results from survey*

To gain insight into specific features target users would want, a survey was conducted. The survey was limited to six questions to encourage more people to complete it, the question where aimed at finding out if people would be open to an electronic receipt system and the budgeting features they wanted it to contain. The survey was very successful, with about 100 people completing it, and very useful in deciding the functionality of the application.

Figure 6 shows that about 80% of people would like to automatically keep track of their spending, so it was decided to make this a priority for the application and extremely easy for the user to view.

Other data collected from the survey showed that approximately two thirds of the people who completed the survey checked their online banking once or more times a week – sometimes daily. This indicates that the majority of people are open to managing money and personal finances from their smartphones, which is of the up most importance to the success of wide scale adoption of this idea.

Another key element to deciding what the application capabilities would be was the open-ended question, which allowed the participant to suggest a functionality they would like. Some of the responses were: 'location and list of shops that I have been given the receipt from', 'Breakdown of what I'm spending money on (food, rent, clothes, etc.)', 'How much money would I have spent at the end of the month at this rate', 'To tell me how much I can spend on average per day based on my monthly income', [Automated]'Shopping list' and 'A graph to quickly view so you can view your changes in daily or weekly spending.'.

Due to the time constraints of this project, not all of the feasible suggestions considered relevant to the project's goal could be implemented although it would be ideal. Selected were the most useful, most fulfilling to the design criteria, and most realistic for implementation in the prototyping process.

# 8 CONCEPT DEVELOPMENT

Moving on from the research and concept selection to making the project a reality, it was necessary to downscale and divide the project. To realise a working prototype this was vital due to the limitations faced;

time, man power and experience. The most prominent divide was between the vendor-side development and the application development

## 8.1 VENDOR-SIDE DEVELOPMENT

As well as ensuring that the customers receive the good user experience, the other major group of the project end-users, the vendors, must also be taken into careful consideration, to enable an easy adoption of the system. This will be necessary for the project to be ultimately successful.

### 8.1.1 NFC Communication

The vendor side of the project is able to transmit wirelessly the receipt information through Near Field Communication (NFC) to the customer's smartphone. NFC utilises electromagnetic induction between two sets of antennae to transmit data over the industrial, scientific and medical ('ISM') radio band of 13.56MHz. (43) It is only capable of transmitting small amounts of data quickly over short distances, making it an ideal method of transmission for the project. (44)

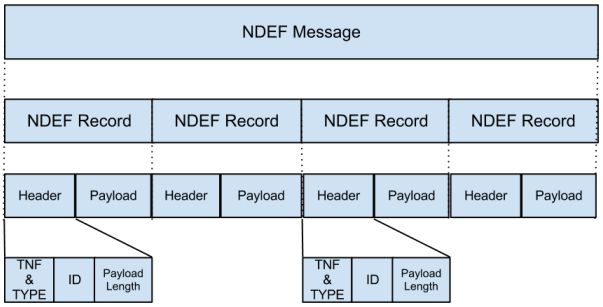


*Figure 7 - The Data Hierarchy In a NDEF Message*

In the development of the project, a mock set-up of a vendor point of sale system was made and used to test the system. The mock POS system setup was similar to those popularly found in commercial establishments: a computer using the Linux operating system (45). This also eases the development of the vendor-side software and hardware. This is due to greater compatibility for the open-source drivers, a software-hardware interface, in the Linux environment. This was especially important for the use of a NFC transceiver in the project. (46) The same set-up process is far more convoluted and complex on other operating systems in comparison, such as Windows and Mac OS X, which both have limited support by the Python NFC interface software library that was used, `nfcpy`. (46)

### 8.1.2 Initial Development

In the initial stages of development, a commercial NFC reader was used as the NFC transceiver. This was the 'ACR-122U Card Reader' produced by ACS. (47) It was chosen over other choices due to its low cost, which was £32.99 at time of purchase and availability. (48)

However, after early experimentation, clear incompatibility issues between the ACR-122U Card Reader and `nfcpy` emerged. The issue arisen because many of functions provided by the PN532 contactless embedded integrated-circuit chip were limited by the Card Reader's controller, which implements a USB-CCID interface to communicate with the host computer. (49) The `nfcpy` library does not support the USB-CCID interface fully, which caused a breakdown in the dialog between the host computer and the Card Reader controller. This incompatibility caused timeout issues after around five seconds, in which the controller fails to respond in a timely manner to commands from the host computer. As well as timeout issues, the Card Reader crashed after each data transmission, the only resolutions to this was to disconnect physically then reconnect the device. The Card reader also had a max transmission capacity of around 250 bytes, which is about a quarter of the size calculated needed for a typical receipt, and would be insufficient in this project.

Due to these technical issues, the development switched using a DIY Adafruit PN532v1.6 board, which enabled direct communication from the NFC transceiver to the host computer in the POS system. (50) This eliminated issues with the limited ability of the USB-CIDD interface in the ACR-122U. This also eliminated all issues with the NFC transmission to the target (i.e. the customer's smartphone).

### 8.1.3 The Wireless Data Exchange

The receipt needs to be transmitted to the intended target in the correct format. When transmitting data via NFC the file intended has to be converted into a binary format to act as a bridge language between the point of sale system and the customer's phone. Therefore, files need to be converted into the NFC Data Exchange Format (NDEF) when sending over NFC. (51) The NDEF messages can be used to exchange files between two devices, namely the vendor's POS system and customer's phone, in peer-to-peer mode so that the devices can understand each other in a meaningful manner.

An NDEF message begins with a Type Name Format (TNF) to indicate what the data type during the transmission. The TNF is also known as the media-type, which indicates many data types, such as "image/png", to describe an image, or "text/json" to describe a data in the JSON format. (52) The latter JSON format was implemented in the project, and will be discussed in detail later.

This format is understood by all Android devices running Android 4.0 (API level 14) and above, which is currently 97.3% of all devices. (53) The Android operating system starts the application registered to handle the TNF indicated in the NDEF message. If the application is not installed on the device, the application manager, Google Play Stores, is launched to prompt the download of the ReceiptBook in this case. (52)

This was facilitated in the `nfcpy` software library, which is capable of formatting the JSON receipt data into a NDEF Message. (54) This ability was used for the development of the project. The PN532 NFC transceiver was also interfaced with the ReceiptBook backend services using the `nfcpy` library. This achieved the goal of enabling the transmission of data from the vendor to the customer.

### 8.1.4 The Receipt Data Format

A data structure was needed to encode the receipts' information. The choice of using JavaScript Object Notation (JSON) was made to fulfil this role. This was because JSON is an incredibly widely supported open text-based format, which is both easily read and written by humans and machines. (55) This format is based on a subset of JavaScript, which uses conventions similar to the C-family of languages. This made it an easy data-interchange format, with good support and compatibility across multiple programming languages, including those used in the project, namely Python, Java with Android and Javascript.

The JSON format structures data in a collection of value and name pairs in an ordered list. (56) This structure is similarly found in all popular programming languages; therefore, for the receipt data format to be interchangeable, it has to be based on these structures.

Included in the Appendix C, is an example JSON data file for a typical receipt issued by a high street store, in this particular case Sainsbury's was chosen. In Figure 15, the receipt's Universally Unique Identifier can be seen. This is an individual 128-bit number associated with this particular receipt and will be used in transmissions between backend processing. (57)

Basic information about the vendor found atop of most paper receipt, this is shown in the JSON format in Figure 16. Note that the 'Time' is given in Unix time, which is the number of seconds elapsed since midnight 1 January 1970. (58) The time given in the sample receipt is Thursday, 18 February 2016 13:57.

In Figure 17, the itemisation of the receipt can be seen. This part shows how each individual item bought is categorised and contains all information regarding discounts and taxes regarding the items. Figure 18 shows a section of the JSON data, which contains information regarding how the payment was made. In this example, this was segmented into two payments method: one with cash and the other by debit card. This illustrates the different ways the JSON format would incorporate the multiple payment methods.

Figure 19 shows the JSON data containing all the rewards and miscellaneous information. The rewards include the shops reward points as well as vouchers, which are often printed alongside the receipt, which are tailored for each individual customer based on their purchase.

Similar to the receipt, each voucher have its own UUID and the number for expire is the Unix time for when the voucher expires. This is vitally important to shops as these vouchers are often ignored by consumers due to their tedious nature and the difficulty to keep track of. Mobile based vouchers is the current trend which shows no sign of slowing its rapid increase in usage and will soon become a standard practice across a range of shops. (59) If these are stored within the application, the user will have easy access to them at all times which promotes their use, benefiting both the shop and the user.

## 8.2 Mobile Application Development

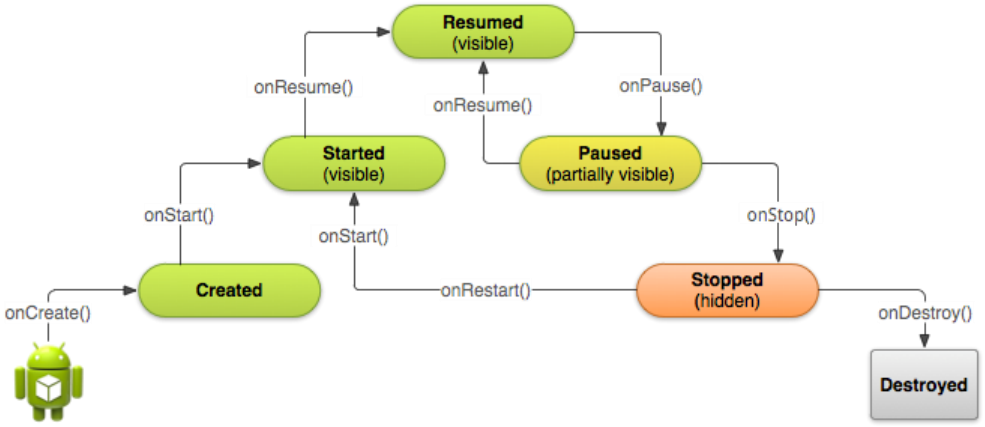


*Figure 8- Android Application Activity Lifecycle (60)*

The figure shown above details the lifecycle of the application. When the application is selected from home screen, `onCreate` method followed by `onStart` method is called and the application remains in `onResume` method until the application is closed. The main user interaction occurs during `onResume` (60).

### 8.2.1 Overview

The presentation layer (layout) is programmed using Hypertext Mark-up Language ('HTML') with Cascading Style Sheets ('CSS') and Javascript ('JS') and the data access layer (back-end) is programmed with PHP. HTML and CSS is used as a layout template and Javascript is used to make the template interactive. PHP is then used to carry out any data logic functions. The presentation layer can be rendered on many platforms, using a browser, thus allowing for even greater cross-platform compatibility than a pure Android-only development. This method introduces delay in loading the HTML due to the necessity of internet access to access the features of the application.

During the development of the Android application, Extensible Markup Language ('XML') was used for the layout, whilst the logic of the mobile application was written in Java, using the Android Application Programme Interface ('API') to access native functionalities provided by the operating system, such as near-field communication ('NFC'). The mobile application was then developed and compiled inside the Android Studio Integrated Development Environment ('IDE').

Inside the mobile application, the HTML layouts are rendered and encapsulated inside `WebView` (61), an inbuilt method supported by Android API. This allows the functionality and layouts of the application to be easily adaptable. The similar process can be used to create an iPhone application.

An issue that was encountered was that `WebView` does not support Javascript by default; hence, much of the interactive functionalities did not work as expected. A solution was found that this security feature could be adjusted via the `setJavascriptEnabled` (61), a method that provided `WebView` access to the Javascript engine.

Nonetheless, the receipt can still be retrieved at the vendor's Point-of-Sale ('POS') without an internet connection, as NFC functionalities are provided offline using Android API. The NFC functionality provides direct communication between the phone and the NFC reader at the POS. On Android, this is enabled using `Intent`, an Android-specific internal datagram, and methods from the Android NFC library. The receipt data is stored and then manipulated when internet connection becomes available.

### 8.2.2 NFC Functionality

Whilst the mobile phone is powered on and in use, the mobile operating system is continuously searching for a NFC communication. Once a NFC data exchange dialog has been established, the operating system passes the received data to the ReceiptBook application, where the parsing of the data takes place.

The verification of the data integrity then takes place inside the application, where the data is checked to be correctly formatted and not corrupted. The verification result is encapsulated with the original data in an `Intent`. An `activity`, which is a logic controller inside an Android application, is then activated by the `Intent` to obtain the data from the operating system; the `Intent` used here is called `ACTION_NDEF_DISCOVERED`. The data from the NFC dialog is stored in a data structure called `NdefMessage`, which consists of one or more `NdefRecords` (62). Each `NdefRecords` consists of a header, which contains the metadata, and a payload that contains the receipt's data from the vendor's POS.


*Figure 9- NDEF Data Abstraction*

The data from the payload is obtained using the `getPayload` method and then passed as an array of strings, in preparation for manipulation. For this process to occur, all receipts have to be generated in an appropriate NFC Data Exchange Format ('NDEF'). The receipt data is formatted in the JavaScript Object Notation ('JSON'), which is both human-readable and easy for machines to parse. This choice aids development of the application in easing the debugging process.

However, using the JSON format requires a larger storage capacity and higher bandwidth than if it was formatted in a compressed binary format to store the same receipt data. On the other hand, the alternative binary format is not human-readable and thus more difficult to work with during development of the application.

Once the receipt data has been retrieved, it is stored in the internal storage of the application by submitting an `INSERT` query (61), which inserts the receipt entry into the Android built-in data storage facility, SQLite. The application also uses `getActiveNetworkInfo` to check continuously for internet availability, then retrieves the data from storage once `isConnected` returns true and sends the data to the backend for processing (61).

### 8.2.3 Implementing Features

The application can use the data retrieved to implement different features. The application can search for receipts, display specific receipts, use receipt data to show monthly spending projection, display spending by product category and display a breakdown of spending by vendor for each category and also award users for their efforts.

The access and display of data is done using a PHP framework, Laravel. The framework features a Model-View-Controller programming paradigm. The 'Model' allows data to be retrieved and processed from the database and input into a 'View', a fixed layout template. The layouts are decomposed and the variables that require data input are declared to enable efficient reuse of HTML code. A templating engine is used to form the layout from its constituent components. This process is triggered from 'Controllers'. These are composed of functions implementing the logic that retrieve and process the data according to the user input.

#### *8.2.3.1 Data Categorisation*

In order to manipulate the receipt data, the data has to be categorised and this is done using an internal SQL database, SQLite

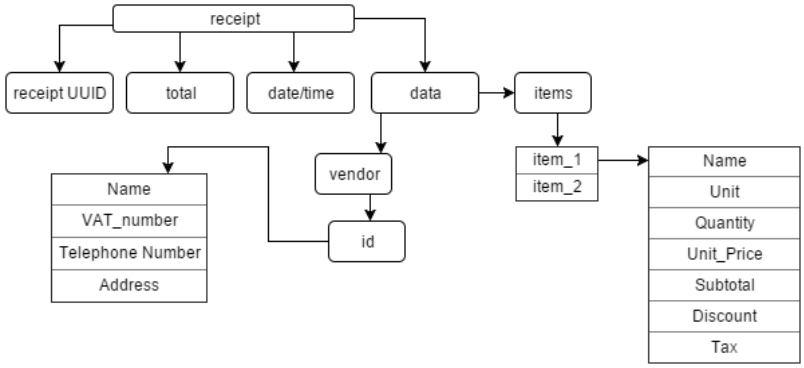


*Figure 10-Diagram showing relationship between variables*

To start with, the JSON data found in the payload has to be read by the programme and this is done using the dass `JSONParser`. This provides access to the JSON data structure and various objects can then be input into a usable data format as shown above. Then, using `JSONReader` (61), a data structure as the one shown above can be created by retrieving object values using the `getJSONObject` method and inputting these values into a SQL database that can be built into the application using the class `SQLiteOpenHelper` to create a `SQLiteDatabase` connection. (63)

#### *8.2.3.2 Search for Receipts*

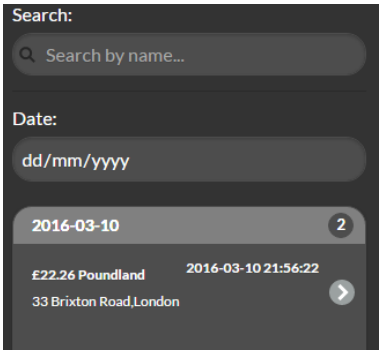


*Figure 11-Search Page*

The Search front page includes search functionality, filtered by shop, shop address or date. The receipts are displayed in a table with the date included in the table header. The text search widget is built-in using a Javascript library, jQuery. The widget compares the user-input text with the text in the table and if it identifies similar strings, it returns the rows identified. The value of user input data is obtained using the string found in the attribute `document.getElementbyId('ID').value` where `ID` refers to the identification for the widget specified in the HTML layout.

As for searching by date, this was implemented in the backend. PHP has a `date` function which is used to generate the dates for the table header in a searcheable format. The identification of the right elements of the table follows the same principal as that of the search widget.

#### *8.2.3.3 Display Receipts*

The data from the receipt is accessed and displayed when a receipt element is clicked on the search page. This is done by setting the `onclick` event to trigger the opening of the detailed receipt view. The programme identifies the right receipt by matching the receipt IDs, which is a numerical number, assigned to the receipt based on the order it was received.

The data from the receipts is accessed using `getReceipt` function within the Search Controller. The function calls the receipt database using its unique ID and uses a `view` to call the desired layout. This allows the database to fill in the field data into the `view`, which is identified by its variable name, e.g. 'subtotal'. Thus, it is important to ensure the variable name in the layout is consistent with the fields' name in the database.

#### *8.2.3.4 Budgeting*

The budgeting feature is a user-interactive feature, which allows users to customise their application. Users can customise overall monthly budget and budget for each product category. The user can navigate to a page with the breakdown of the category, which is implemented using *the* `onclick` method call.

For this to be possible, the products need to be categorised. Five different categories are chosen to simplify the development process, namely, food, drink, leisure, fuel and others. The Google Product Taxonomy text file is used to categorise the products. (64) The text file is read using `fread` PHP function and processed into an indexed array. The array data structure is then stored in the backend database. The item's name from the receipt is then compared to the product's names in the database found in the internal storage of the application and the category name and id is retrieved.

To generate the pie chart, each category's percentage spent needs to be calculated. The items are first grouped into a category using `groupBy(category_id)` and the grand total of all the receipts are calculated. A division is then executed for each category to calculate the ratios to generate the pie chart. As for the individual breakdown, the `vendor_id` is used to group the vendors to carry out similar arithmetic to generate the pie chart.

The budget leftover is also calculated by subtracting the total spent from the budget set.

#### *8.2.3.5 Projection*

The projection involves the computation of three different graphs: the user's actual cumulative spending, the budget and the projected spending based on the past. The user inputs the budget, start date and end date, which allows for flexibility of application usage.

Firstly, the cumulative spending of each day is calculated by summing the total of all of the user's receipts each day. This is then plotted on a graph in the projection view,

The monthly projection graph uses regression through origin formula. This takes the cumulative user spending and days as an input and outputs an expected line graph based on the user's behaviour.
This is implemented using the following formula to compute the gradient, where $x$=number of days from start, $y$=cumulative user spending:

$$\frac{\sum xy}{\sum x^2}$$

The expected projection graph plots a line using the gradient calculated from the regression formula above, for the budgeting duration, calculated from the start and end dates set by the user.

Similarly, the budget is shown by plotting a line using the gradient calculated by multiplying the budget amount per day by the budgeting duration, which are both set by the user.

#### *8.2.3.6 Awards*

ReceiptBook also has system in place to award users for using the application regularly. The implementation of an award system is used to encourage the uptake of the application, which will ease implementation of the product.

The awards available are Projection Perfection, Crazy Collector, Big Saver and Cheap Shopper Week. Projection Perfection signifies that the user-spending graph has matched exactly to the expected projection graph at the end of the month. This is done by computing the gradients of both graphs and checking if the values are matched. Users who meet or spend below their budget are awarded with Big Saver and users who have collected more than an appreciable numbers of receipts in a month are awarded with Crazy Collector. Cheap Shopper Week is awarded to users who have collected more than 20 receipts in a week but still have their projected values below their expected budget values.

This functionality is implemented by showing a symbol for each of the award; each symbol is shown in a colour indicating if the award has been achieved or not. When the award is achieved, the activated image is rendered from the application's internal storage and the inactivated image is replaced with the new activated image.

### 8.3 NEXT STEPS

The project was approached in a module fashion, in order to complete small deliverables in parallel. When the modules where combined there were incompatibility issues, this required stringent testing. Testing was also needed because it handled sensitive information about the user and payment details.

## 9 PRODUCT TESTING

The testing of the application is essential during development process to identify and remove bugs. The earlier in the development process the bugs are found, the easier it will be to remove them.

### 9.1 ALPHA-TESTING

Alpha testing refers to the testing done within the team. Initially, each module was tested individually before creating interactions between modules. This allowed the development team to identify and remove bugs from an early stage. The team face most difficulties with debugging the vendor-side module, which required data to be written to a NFC-writer. The initial problems were to do with incompatible writing devices. Most of the devices purchased could only be easily debugged when using the Ubuntu operating system. One of the devices was not compatible with the programme, as the NFC chip could not be accessed directly. Another device was unable to write sufficient data to the chip. These issues were eventually by using the `nfcpy` module supported by Python and replacing the existing chips with a PN532 NFC chip.

The layout and data functionality was initially debugged by loading the programme onto a webpage and testing if the inputs and outputs were as expected. After the webpages were encapsulated within the application, the debugging was done using Android Studio and an Android phone.

#### *9.1.1.1 Black-box testing*

Black box testing refers to testing the functionality of the application with no knowledge of the internal structures of the programme. This testing mostly checks if the programme works for any given random user input. Members in the group who were not involved in application development were used for this testing. Initially, there were issues with loading of pages and the monthly projection did not reflect the right values. This was fixed by using asynchronous JavaScript and XML ('AJAX') technique, which allowed data to be updated on the page without having to reload the page. As for the projection, more research into the regression formula enabled the team to identify a more accurate equation that provided the user with more accurate projection values.

#### *9.1.1.2 White-box testing*

White-box testing refers to testing the functionality of the application with the knowledge of the internal structure. Branch coverage testing technique was used to ensure that all the different execution paths would work. This was carried out by the members who were involved in application development. The main issue with such testing is the large amount of time required, as each branch within the programme had to be tested individually. However, it was made possible by sharing the workload between the three members involved in the testing. This delayed the possibility of beta testing although, eventually, the team managed to complete the testing and carry out beta testing.

## 9.2 BETA TESTING

Beta testing refers to testing carried out externally using members of public. A focus group enabled for the testing to be carried out and a public invite was sent out. The feedback from the focus group was used to modify further the app. The first focus group returned with 70% positive feedback, although there was some dissatisfaction due to layout and functionalities. Initially, users were unable to input the start and end date of their budget and the light grey layout colour was criticised. A second focus group revealed the need to implement an awards system and an individual budget for each category. The final focus group indicated interest in being able to view a breakdown of each category by vendors. Most of the feedback was implemented in the final product. The final focus group also returned with 90% positive feedback.

As for vendors, the team were unable to source a large collection of vendors. Kings Chop Suey House (95 Skinner Street, Stockton-On-Tees, County Durham TS18 1EG) and Pizza House (53 Holyhead road, Bangor, Gwynedd, LL57 2HE) were the two vendors the group managed to source. The final products after the focus groups were introduced to these vendors. Both vendors indicated 90% satisfaction with the product and concept. There was some initial scepticism towards the need to adapt a new system for the concept to work. In the future, the team decided it would source larger vendors who may be able to reach out to a larger customer base.

Additional time would have enabled the team to carry out more modifications of the application. There was also lack of reach to vendors and this will be part of the team's future work. Additional suggestions from the focused group such as implementing more than budgeting features will also be carried out in future work.

# 10 PROJECT MANAGEMENT

In order to have a productive team, we laid down the framework for our roles clearly from the start of term. The framework of the group was as follows:

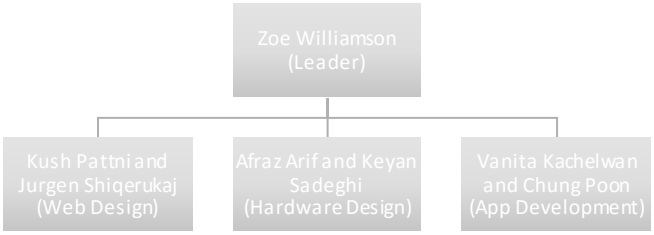


*Figure 12 - Show internal structure of team*

The group meetings were routinely conducted, in the group study rooms in the library as well as in the department computer labs. The meetings were held for 2 hours every Tuesday from the start of term. Apart from a few absences, all members of the group attended the meetings consistently. If anyone was absent, it was required to either make up for their part later if they had to work in the session or they were informed of their duties in time for the next session.

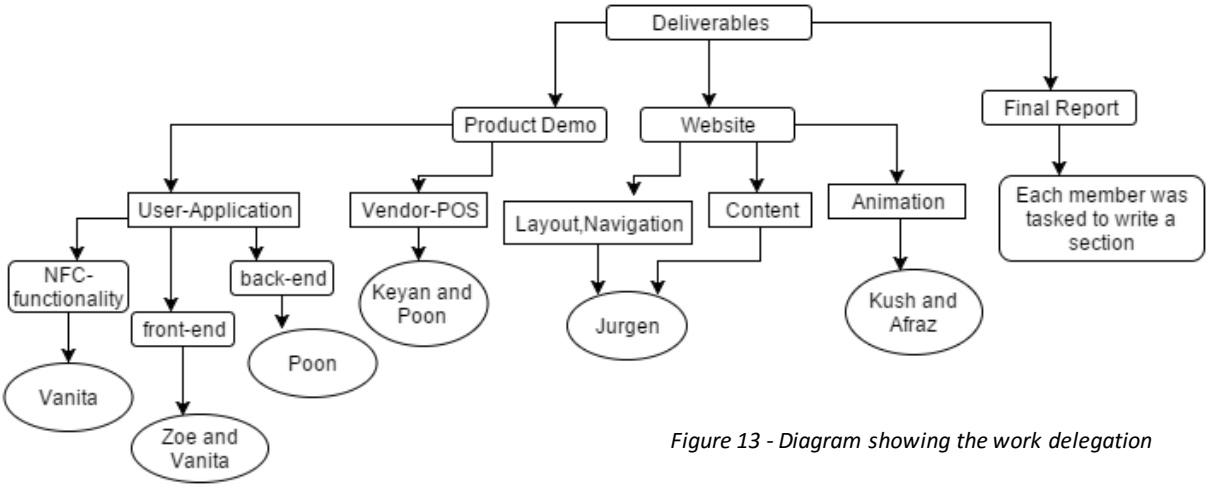


*Figure 13 - Diagram showing the work delegation*

Communication within the group was primarily via a Facebook chat, which allowed fast responses between members – this was especially useful when problems with development arose or when someone needed advice from another member. Additionally the team had a shared Google drive folder, which was extremely useful for file transfer and backing up important files. This allowed the group to work on the project in different locations with ease.

The deliverables were broken up in a top down style, into manageable tasks. The work was delegated among the members of the team based on their knowledge and capabilities. The entire project was completed in a modular fashion to maximise the productivity of the group. To keep track of the work, a timeline was used and meetings were held regularly where individual progress was shared and discussed. The minutes for each meeting detailed the progress discussed and outlined the work that required attention during the week. This enabled the team to set sub-deadlines to track the progress of members' work. Lack of contribution and progress, if any, were also usually addressed during the meetings. The timeline is shown below and meeting minutes have been included in the appendix.

## 10.1 Project Progress

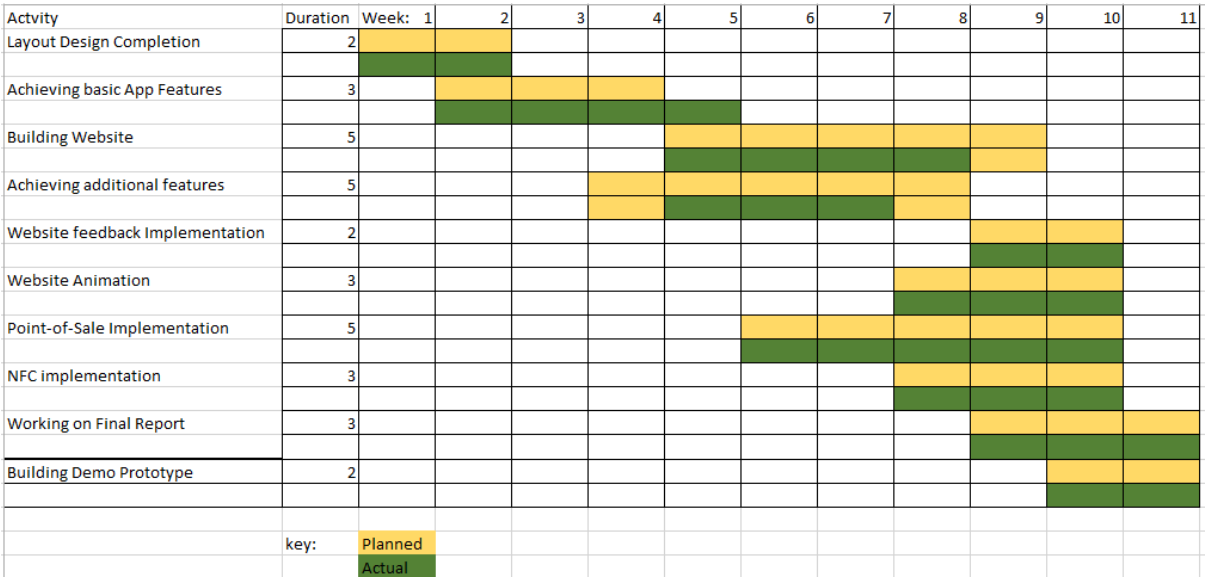


*Figure 14- A histogram showing scheduled and achieved progression*

The figure above clearly illustrates to timeline set for the spring term. The group was very consistent with meeting deadlines and it can be seen on the Gantt chart as most tasks and deliverables where done in the planned duration period. After each milestone, the deliverable was peer reviewed and made sure it is of a standard we all would be happy with.

The group performed efficiently and effectively throughout the term completing and submitting deliverables on time. Several groups meetings took place weekly and provided the necessary hub to share ideas and set tasks. However, there was a couple issues, some included some members of the group not turning up for group meetings and hence some tasks where indeed delayed. A example of this would be "achieving additional features" which was delayed a week, however this wasn't a major issue as the task was completed before its planned finish.

# 11 Future Work

Subsequent work on the project would mainly focus on implementing a fully working Android app, data storage, physical integration of NFC with point of sale devices, additional features for the Android app and engaging in dialogue with local businesses.

## 11.1 Android Integration

Due to time constraints, implementing all feature in an Android application turned out to be infeasible. This is unsurprising due to the complex nature of the project and a lack of experience and expertise in the field of Java development in Android Studio. This could be overcome with increased time and further learning and experience with the development environment.

## 11.2 Cloud Backup

The cloud backup solution which would be executed with an increased timespan would be the native Android Backup Service (65) and the newer Android Auto Backup for Apps (66). Android Backup Service uses

an API on Android devices on Android 2.2 (API level 8) and above, which is over 99.9% of devices (67). It has a data limit of 1MB but due to the nature of the size of files stored (In the magnitude of 1 kB), this means around 1000 receipts would be able to be backed up. Android Auto Backup for Apps is only available to devices running Android 6.0 (API level 23) and above, which currently only applies to 1.2% of devices but is obviously only going to increase in percentage. This API allows for 25MB of backup which is automatically regularly backed up allowing around 25000 receipts to be stored. In extreme circumstances, it would be possible to allow the user to archive the data in the user's own personal Google Drive using the Google Drive REST API (68).

These implementations of a cloud storage backup solution are ideal as they hand off all the server side operations and expenses to Google, a company which specialises in cloud storage. The data would be encrypted and stored for free, allowing data to be easily restored to the user if their local data was erased or they had changed phones.

The downsides of having a cloud backup are mostly insignificant, the main downside being the environmental impact of keeping the data centre running. One of the main reasons for the project is the environmental gain that would be achieved from eradicating the use of paper receipts, so keeping a data centre running could become self-defeating. However, due to the fact that the data being stored is so small, combined with Google's optimisation of server efficiency allowing their data centres to run at 50% energy consumption of a typical data centre and sourcing 37% of power from renewable energy (69), the environmental impact of a cloud backup would be insignificantly small.

## 11.3 Integration of NFC Into The Point-of-Sale

A further avenue of development would be investigating how the NFC writer and the nfcpy libraries integrated in a functional point of sale device. Currently, the NFC writer has only been tested on Ubuntu and not any Windows Platforms, which many point of sale machines operate on (70). These Devices would need to have an API to plug into so that they can send files to the customers phones via the NFC terminal. The NFC terminal which was used for testing turned out to have certain incompatibilities with the python library, nfcpy, which was chosen to beam the receipt files. Therefore, further testing would be required on different NFC terminals to find a suitable replacement.

Contactless payment has become commonplace in the UK, with over 250,000 locations accepting the payment type (71), meaning that point of sale systems with a NFC terminal integrated to process these payments are found from the largest chain retailers to small locally owned businesses. Therefore, the path of least resistance for the vendor side would be to utilise these NFC terminals thus saving the financial burden of having to invest in new hardware. More experimentation and research would have to be undergone to realise the practicality of this solution.

## 11.4 Smart Categorisation and Machine Learning

One of the features that could be developed is the ability to sort through receipts by item category. If a receipts contents could be broken down so that each item was uniquely understood by the app, the analytics on offer to the user would be unparalleled. It would be able to show breakdowns of expenditure on a variety of categories, allowing for smarter budgeting. This could be achieved by integrating Content API for Shopping (72) and Product Advertising API (73) from Google and Amazon respectfully as well as other digital marketplaces' APIs to build a database of items. Food in particular could be handled using the United States Department of Agriculture's National Nutrient Database API (74) and Open Food Facts (75) open source food database to provide data for tens of thousands of products. This would then be supplemented by user-generated content to aid in filling in missing data.

Combining machine learning and contextual awareness could to create an intelligently generate suggested shopping lists and reminding users what they need to buy when in an appropriate situation such as walking near shops or actually entering the shops. This would be an extremely advanced development but not out of the realm of possibility as other applications on the market currently implement sophisticated uses of machine learning (76).

## 11.5 Health Advice

In the UK 61.7% of adults are obese or overweight (77), which is something, which could be combatted by providing nutritional information about the groceries the user purchases. This would help illustrate the root problems in diets and would provide an easy way to collate the data (as opposed to current methods of scanning individual bar codes) even in time constrained environments e.g. In a bar, where calorie intake can be very high and difficult to keep track of.

## 11.6 Integration of Online Purchases

The Project does not need to be limited to physical shopping, online transaction (such as eBay or Amazon) receipts could be included as well to create a central platform for the amalgamation of all receipts. This could be expanded to include vouchers and rewards from specific retailers as part of their promotional exercises.

## 11.7 Moderation of Spending

Excessive spending on vices and shopping to temporarily raise moods is a problem in developed countries (78). While the system is already able to categorise spending, habits could be easily tracked and monitored to ensure they remain in moderation. This could be paired with predefined budgets to provide live budget alerts and guidance. This would then allow for highlighting of problem spending areas and offer solutions to combat the issue such as price comparisons for nearby establishments, using location-positioning services.

Elements of parental control could be created so that parents can have access to evidence of what their children are spending money on, how often and if overall expenditure could be reduced. This could be used by the young adults to prove their fiscal responsibility. People receiving financial support could produce analytics to demonstrate that the money is being spent responsibly.

## 11.8 Integration of Payment and Implementation

Another idea would be for the application to merge payment with receipt collecting so that it utilises the host-based card emulation (79) abilities offered by Android. This would provide the application the ability to act as a contactless bank card in the same way Android Pay, Samsung Pay and Apple Pay all work, but at the same time take the receipt from the NFC terminal and using it for budgeting and spending analysis which is not currently done. This would allow the user to have a complete module that could pay, keep receipts and help them manage money. This idea is less feasible on the current project platform as it would necessitate advanced security.

Actual trials of the project would need to be run at local establishments to monitor the feasibility, real world technical issues and user habits – it would need to be put through alpha and beta testing before being released publically. This would start with a small-scale trial and would increase in size with each trial. This would involve significant dialogue with local and national vendors to highlight ways the project can improve.

# 12 CONCLUSION

The report details how the team has managed to conceive and implement a solution to a few problems, namely the environmental impact due to using paper receipts and the lack of easy budgeting solutions available.

The report outlines the development process of the product from the concept ideas to the testing of the actual product. The solution to the problem outlined, which comes in the form of an application, ReceiptBook, is a concept yet to be implemented in United Kingdom and holds great potential of becoming a widely used product. The user acceptance of the product as seen from focus groups further signifies the need for this product. The technical aspects involved to enable the project to be a success has also been included in the report. Non-technical aspects of group work such as group management, research and work delegation are also covered.

The future work to be done signifies the potential that can actually be achieved by the product if implemented. It can be concluded that the group should focus on marketing the product to large-scale vendors as a next step to acquire a wider range of feedback and be able to market the product before competition is introduced.

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# APPENDIX A. PRODUCT DESIGN SPECIFICATION

Project: e-Receipt Date: 2015 Dec 20
Author: Team e-Receipt

A1. Performance

The performance of the system – both the vendor side and the customer interface should have high performance, in terms of speed and usability. The system should perform quickly and the point of sale, with ease to both vendor and customer.

A2. Environment

Consideration to the environment in which the system will be used needs to be taken. Any system to be implemented will be used with high frequency, so it is necessary to take this into account in its' design.

A3. Life in Service

Any hardware that would be implemented would need to be robust enough to withstand frequent use, and have a long life. This is necessary to make the project viable financially.

A4. Maintenance

Regular updates required for vouchers and deals and updates to deal with any glitches in the programme. People with expertise in Java and android applications required for maintenance.

A5. Target Product Cost

The product cost of the hardware implementations and modifications to upgrade existing point of sales should be kept low to encourage uptake of the system. Since the main beneficiary of this project is actually the end-user, the end-user may have to pay for subscription/premium plans in order to subsidise the cost of deployment.

A6. Competition

The result of this project should be different to current technology offering a similar service, providing innovation to the customer in some for. Be it advancing on current technology or entirely new technology.

A7. Shipping

For any 'add-ons' required for the vendor, it is necessary that they be able to be shipped in large quantities and at a financial viable price. The user-end solution to the defined problem should not require expensive shipping, ideally no shipping for the user. This is not required for the prototype.

A8. Packing

To protect the hardware in transit, a small amount of bubble-wraps may be needed to prevent damages. For any software implemented, the code has to be signed to enable verification of trusted authorship. This is not required for the prototype.

A9. Quantity

The deliverable for this project is only one prototype. Looking to the future, should the product be launched you would need enough on the final system to implement them in the majority of tills across the UK.

A10. Manufacturing Facility

The prototype will be built within the department of EEE with EEE facilities. If the project were to be fully developed it would most likely be manufactured by third party companies.

A11. Customer

Any till add-ons should be of relatively small size as to not look off putting or take much space at tills where a transaction would be taking place. Any changes to the customers normal payment routine should be kept to an absolute minimal, be it the time and effort it takes to use the system, or an item they need to carry, or an application on their phone.

A12. Size

Again any till add-ons need to be as very small. Furthermore if a system on a smart phone was to be implemented it would need to be developed to minimise the amount of data used – most apps take around 50MB – 100MB.

A13. Weight

This design criteria is not really applicable on the vendor side as nothing has to be carried. However anything that the customer has to carry has to be as light as possible, and easy to carry in a pocket, alongside a wallet and a phone.

A14. Materials

Not applicable.

A15. Product Life Span

Ideally any point of sale adaptations would require an extremely long life span, as you do not want the system to fail frequently. The customer system should have a life span of at least two years, which is approximately equal to the lifespan of the average mobile phone.

A16. Aesthetics, Appearance and Finish

All aspects of the project should have a professional finish, of a standard similar to that of current card and till systems. The prototype for this project should try to reach this, however at this stage it is not entirely necessary.

A17. Ergonomics

The entire system needs to be designed for easy adoption into the normal check out process, and been efficient for both the customer and vendor.

A18. Standards and Specifications

Not applicable.

A19. Quality and Reliability

Any adaptations to the current system need to be of the highest quality to reassure the users that it is a sound system. It also needs to be 100% reliable, as it is not any use to have a system that will only collect the customer's receipts some of the time.

A20. Shelf Life (storage)

N/A

A21. Testing

The system need to go through rigorous testing to ensure its reliability. The testing should focus on the file transfer continuity, storage of the receipt and accuracy of the budgeting data provided. The final product and it's usability should also be tested.

A22. Processes

N/A

A23. Time Scale

The time-scale for the current design and prototyping phase is 6 months

A24. Safety

Security of the data is a priority as it contains sensitive information. It is therefore of extreme importance that during transmission and while stored that the data is only accessible by the intended user.

A25. Company Constraints

Technological knowledge and experience is limited and members are required to familiarise themselves with the necessary programming languages required to implement the solution and any other technology required within the given limited time.

A26. Market Constraints

The reach of company to major supermarkets is limited due to lack of an established brand. Public reach and support is also limited due to lack of established name and lack of advertisement funds.

A27. Patents, Literature and Product Data

N/A

B28. Legal

See Data protection act 1998

A29. Political and Social Implications

It will be a social change to accept electronic proof of purchase as a legitimate proof. It also requires a slight change in vendor and customer behaviour, which is achievable – contactless payment has been widely adopted by people in the UK.

A30. Installation

Installation and integration with the Point-of-Sale systems will be part of the challenge to encourage adoption. The installation will have to be quick and not technically challenging, as it will not be a person with extensive knowledge of the system who will be installing it on a large scale. The customer system also has to extremely simple, to make adoption of the system as easy as possible.

A31. Documentation

The system, if it is to be well maintained, has to be well documented, especially for the software written such that all of its functions are well explained, and it will not slow down future adoption and expansion on the system.

A32. Disposal

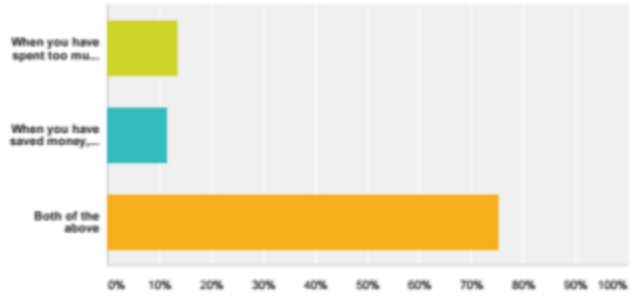
Any hard ware should be disposed of according to the law, and any adaptations to things like smart phones can be reversed. Individual receipts could be disposed of at the customers discretion.

# APPENDIX B. SURVEY RESULTS

Q3 Customize Export

**Would you prefer the app to tell you:**

Answered: 97 Skipped: 2

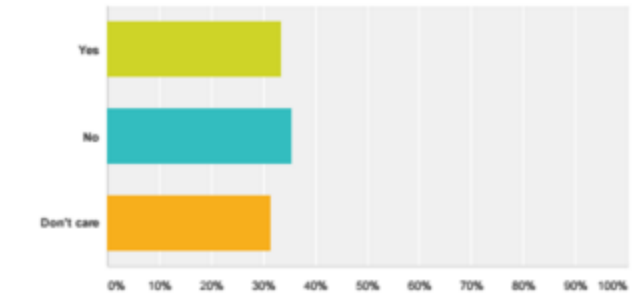



| Answer Choices | Responses | |
|---|---|---|
| When you have spent too much money (on specific area of products, e.g. clothes) | 13.40% | 13 |
| When you have saved money, or come in under budget | 11.34% | 11 |
| Both of the above | 75.26% | 73 |
| Total | | 97 |

Q4 Customize Export

**Would you be interested in an app that offers lifestyle/ health advice depending on your purchases?**

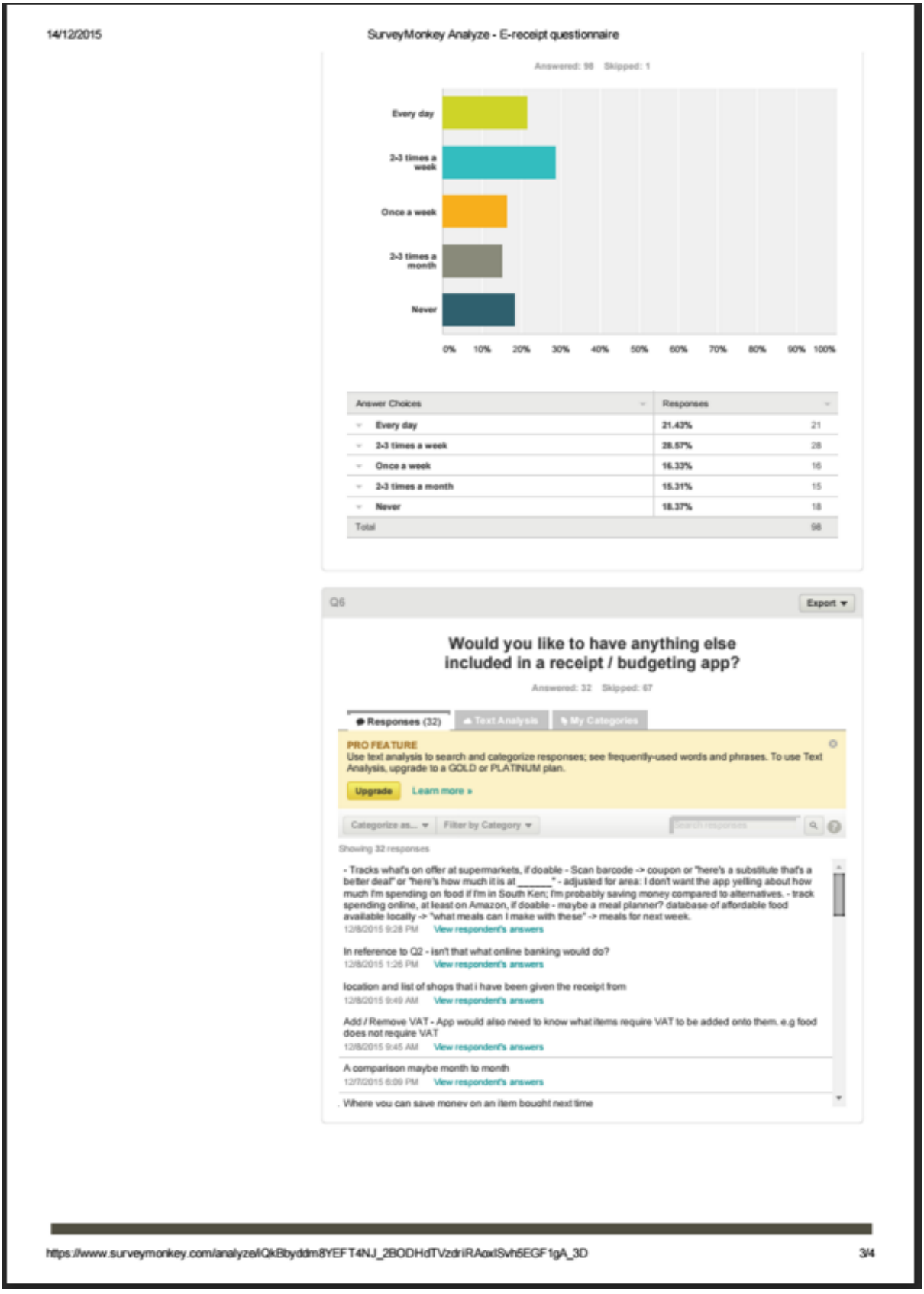
Answered: 99 Skipped: 0




| Answer Choices | Responses | |
|---|---|---|
| Yes | 33.33% | 33 |
| No | 35.35% | 35 |
| Don't care | 31.31% | 31 |
| Total | | 99 |

Q5 Customize Export

**How often do you use online banking on your phone?**



14/12/2015 SurveyMonkey Analyze - E-receipt questionnaire

Answered: 98 Skipped: 1



| Answer Choices | Responses | |
|---|---|---|
| Every day | 21.43% | 21 |
| 2-3 times a week | 28.57% | 28 |
| Once a week | 16.33% | 16 |
| 2-3 times a month | 15.31% | 15 |
| Never | 18.37% | 18 |
| Total | | 98 |

Q6 Export

**Would you like to have anything else included in a receipt / budgeting app?**

Answered: 32 Skipped: 67

Responses (32) Text Analysis My Categories

PRO FEATURE
Use text analysis to search and categorize responses; see frequently-used words and phrases. To use Text Analysis, upgrade to a GOLD or PLATINUM plan.

Upgrade Learn more »

Categorize as... Filter by Category Search responses

Showing 32 responses

- Tracks what's on offer at supermarkets, if doable - Scan barcode -> coupon or "here's a substitute that's a better deal" or "here's how much it is at _____" - adjusted for area: I don't want the app yelling about how much I'm spending on food if I'm in South Ken; I'm probably saving money compared to alternatives. - track spending online, at least on Amazon, if doable - maybe a meal planner? database of affordable food available locally -> "what meals can I make with these" -> meals for next week.
12/8/2015 9:28 PM View respondent's answers

In reference to Q2 - isn't that what online banking would do?
12/8/2015 1:26 PM View respondent's answers

location and list of shops that i have been given the receipt from
12/8/2015 9:49 AM View respondent's answers

Add / Remove VAT - App would also need to know what items require VAT to be added onto them. e.g food does not require VAT
12/8/2015 9:45 AM View respondent's answers

A comparison maybe month to month
12/7/2015 6:09 PM View respondent's answers

Where you can save money on an item bought next time

https://www.surveymonkey.com/analyze/iQkBbyddm8YEFT4NJ_2BODHdTVzdrIRAoxISvh5EGF1gA_3D 3/4

Link to all responses
https://www.surveymonkey.com/results/SM-SBN28YMJ/

- Tracks what's on offer at supermarkets, if doable - Scan barcode -> coupon or "here's a substitute that's a better deal" or "here's how much it is at _____" - adjusted for area: I don't want the app yelling about how much I'm spending on food if I'm in South Ken; I'm probably saving money compared to alternatives. - track spending online, at least on Amazon, if doable - maybe a meal planner? database of affordable food available locally -> "what meals can I make with these" -> meals for next week.

12/8/2015 9:28 PM View respondent's answers

In reference to Q2 - isn't that what online banking would do?

12/8/2015 1:26 PM View respondent's answers

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12/8/2015 9:45 AM View respondent's answers

A comparison maybe month to month

12/7/2015 6:09 PM View respondent's answers

Where you can save money on an item bought next time

12/7/2015 5:06 PM View respondent's answers

Monthly comparisons and yearly profiles of spending

12/7/2015 4:46 PM View respondent's answers

A graph to quickly view so you can view your changes in daily or weekly spending.

12/7/2015 4:04 PM View respondent's answers

For business automatically calculate how much tax you spent and also have s choice to make something a "personal" or "business" expense

12/7/2015 3:57 PM View respondent's answers

Month by month comparisons would be good!

12/7/2015 3:48 PM View respondent's answers

Breakdown of what I'm spending money on (food, rent, clothes, etc)

12/7/2015 3:19 PM View respondent's answers

Search functionality using OCR

12/4/2015 12:18 PM View respondent's answers

How much money would I have spent at the end of the month at this rate.

12/4/2015 12:03 AM View respondent's answers

A way to share/split receipts with other users of the app. As a further development, it can learn from your spending habits to make personalised shopping lists. E.g. if it notices that you bought a pack of 24 eggs and then nothing for 2 weeks, then 2 packs of 6 eggs in the following week, it would suggest to buy a pack of 12 eggs in a week's time.

12/3/2015 12:21 AM View respondent's answers

Ability to use different currencies for different accounts, automatic categorization of the items

12/2/2015 6:53 PM View respondent's answers

Track debts (when you borrow or lend money to friend)

12/2/2015 5:50 PM View respondent's answers

Statistics on spending money (i.e. Money spent on a certain area, certain days, month,...)

12/2/2015 4:40 PM View respondent's answers

A social media platform to both share and see what my friends and colleagues purchase on a regular basis. Suggested names include Receiptbook or Budgetgram.

12/2/2015 3:50 PM View respondent's answers

Automatic price comparaison feature for frequently bought items to advise on how to optimise spending by changing supermarkets/ordering online.

12/2/2015 2:11 PM View respondent's answers

Ability to easily download receipts for expense claims etc.

12/2/2015 12:44 PM View respondent's answers

Alarms for when you're about to go over your budget. A rewards system. Integrated VAT for international students

12/2/2015 12:33 PM View respondent's answers

I would be concerned about privacy if it has access to all my receipts especially if metadata is collected

12/2/2015 11:49 AM View respondent's answers

To tell me how much I can spend on average per day based on my monthly income

12/2/2015 11:46 AM View respondent's answers

Vouchers and deals relevant to my spending

12/2/2015 11:35 AM View respondent's answers

Suggest offers based on previous purchases

12/2/2015 11:28 AM View respondent's answers

Yeah, me shopping done frequently

12/2/2015 11:24 AM View respondent's answers

Use App to make purchases, provide recommendations would be great.

12/2/2015 11:20 AM View respondent's answers
N/A
12/2/2015 11:19 AM View respondent's answers
Shopping list
12/2/2015 11:17 AM View respondent's answers

# APPENDIX C. JSON FORMAT RECEIPT SAMPLE DATA

*Figure 15 - Receipt UUID*

```
{"receipts":[
{"receiptUUID": "ee9a871d-19be-4539-9d20-7c077648f48b",
```

*Figure 16 - Vendor Information*

```
"vendor":{
"name":"Sainbury's",
"address":"1 Dawes Road, London",
"telNumber":"02037823873",
"vatNumber":"3272382382" },

"transaction":{
"time":1455803849,
"channel":"checkout",
"operator":"Zoe Williamson" },
```

*Figure 17 - Receipt Items Entries*

```
"items":[

{
"name":"Banana",
"quantity":2.75,
"unit":"KG",
"unitPrice":0.57,
"subtotal":1.57
},
{
"name":"Coca-Cola 500ml",
"quantity":3,
"unit":"pc",
"unitPrice":1.50,
"discount":{
"name":"Buy two get one free",
"original":4.50,
"deduct":1.50 },
```

```
"subtotal":3.00
}],

"tax":{
"taxable":4.50,
"taxRate":0.20,
"vat":0.90 },
```

*Figure 18-Payment and Transaction Information*

```
"payments":{
"totalPayable":6.07,
"totalPaid":6.07,
"methods":
[{"method":"cash",
"amount":4.00,
"info":{
"tendered":4.00,
"change":0.00 }},
{"method":"card",
"amount":2.07,
"info":{
"type":"Visa",
"card":6678,
"authcode":347324 }} ] },
```

*Figure 19-Rewards and Miscellaneous Section*

```
"loyalty":{
"scheme":"nectar",
"number":"63400438723782398",
"points":607,
"info":"You can spend your points online!" },

"vouchers":[ {
"voucherUUID":"91dc5d81-27a4-4d64-bc12-ffe637bfbad4",
"name":"Buy Mouthwash and earn 50 nectar points",
"expire":1455903849 } ],

"misc":"You have saved 3p this shop!" } ]}
```

# APPENDIX D. MEETING MINUTES

Date: 09/02/16

Present: Vanita, Zoe, Poon, Keyan,Kush,Jurgen

Absent: Afraz

Points Discussed

Management

Interim Report badly managed, peer assessment failed. Workload unbalance.

Management of time: follow deadlines more tightly, peer check each other work tightly

To-Do

Vanita: has been working on the mobile app side

Need to delegate task:

Zoe, Vanita: Mobile App Receipt Format to Keyan

Jurgen, Kush – Website Content, Animation

Poon – Upload website files on gDrive

Keyan, Afraz – Vendor-side Program

For next week

Website Content Plan – Insert Pictures that will soon be available, HTML

Keyan to investigate Python/NFC Reader

App devs meet more

Bring Laptop

Book Room- Study Group C

Next meeting on Tuesday

Date: 16/02/16

Present: Vanita, Poon, Keyan, Kush, Jurgen, Afraz

Absent: Zoe(Lab Orals)

Points Discussed

- Video for Website to show how App works- Chromakeying
- Website Progress- Familiarisation with JS, Content Plan achieved
- Work with NFC reader-Keyan
- Create json file for receipt data- format receipt data
- Vendor name
- Vendor contact (Address and number)
- Date and time
- POS operator
- Purchase Channel
- Items (quantity,name,price)
- Subtotal
- Tax
- Payment Method
- Discount
- Total Amount
- Tendered
- Change due
- VAT number
- Receipt number(Barcode)
- Vouchers
- Android NFC reading- SNEP

Tasks

Poon- Create example of receipt file and put on google drive

Keyan, Afraz – Test NFC read/write

Vanita, Poon- Android NFC- SNEP

Zoe- Clean Layout: Transparent Images, Alignment

Zoe-Upload examples of user interface for website/Upload layout files on google drive

Jurgen, Kush – Website layout, Chromakeying

All- Think of App name, Slogan

Date: 23/02/16

Present: Vanita, Poon, Keyan, Kush, Jurgen, Afraz

Absent: Zoe(Interview)

Points Discussed

Progress in Website- Links are working, Content is sorted

NFC Writing works partially- only reads 256 bytes instead of 1MB

Tasks

Vanita, Poon- Android NFC- SNEP

Order NFC reader- email Fobelets about money

Zoe- Clean Layout: Transparent Images, Alignment

Zoe-Upload examples of user interface for website/Upload layout files on google drive

All- Think of App name, Slogan

Read Website Mark scheme- email Fobelets about hyperlinks in report/other stuff

Date: 1/3/16

Venue: Level 2 Seminar Room

Attendees: Jurgen, Keyan, Vanita, Afraz

Points Discussed:

Keyan to put all NFC files on google drive

Work delegation of report

Website review- Almost done apart from animation of how app works

Checkout comments from previous report

Tasks to do:

Afraz & Keyan- Animation for how app works (due on Monday)

Report work(due Sunday midnight)

Introduction/Background-Jurgen

Design Criteria-Vanita

Project Management-Afraz

Future Work-Keyan

Report points-

Intro/Background: Quantify the problem (explicitly outline problem not just qualitatively rather than quantitatively, More background market research to validate our problem(vendor-side), User-side survey explained better

Design Criteria: Have more design criteria and quantify the need for these parameters

Project Management: Create Gantt Chart to outline the progress during the term. Discuss how we achieve our goals in detail

Future Work: Data Storage, Implementation in shops/ trial runs in small shops then expand if successful

*REMEMBER to quantify all your information. Do not just state things without backing them up or explaining why we did them and VANCOUVER REFERENCING