Mobile Technologies Supporting Corporate Loyalty Schemes

Henrik Stepanyan

Bachelor of Science in Computer Science with Honours and Industrial Placement
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Submitted by: Henrik Stepanyan

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Declaration

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Signed:

Abstract

I'll put my abstract here someday...

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Chapter 1

Introduction

1.1 Problem Statement and Motivation

Incentives are powerful tools long employed to encourage certain behaviours. In the context of a business, several implementation options are available, such as posters, emails, websites, employee workshops, and campaigns; but another commonly adopted method is that of a loyalty scheme. Loyalty applications available range from the basic stamp/sticker book, to the more modern smartcards (Fig. 1.1).

Commonly, simple paper-based systems are adopted by businesses due to low cost and implementation times; nonetheless systems like these have several issues

1. Some individuals may lose their stamp cards
2. There is an environmental impact associated with constantly printing stamp cards
3. Paper-based systems are not very secure and open to abuse

An opportunity exists for a general-purpose system to encompass loyalty programs via use of up-and-coming Near-Field Communication (NFC) technologies that are integrated inside modern smart phones. Moreover, elements of 'gamification' can be added as an extra dimension of loyalty to corporate persuasive technologies. (e.g. unlocking badges as they claim rewards, essentially playing versus themselves)

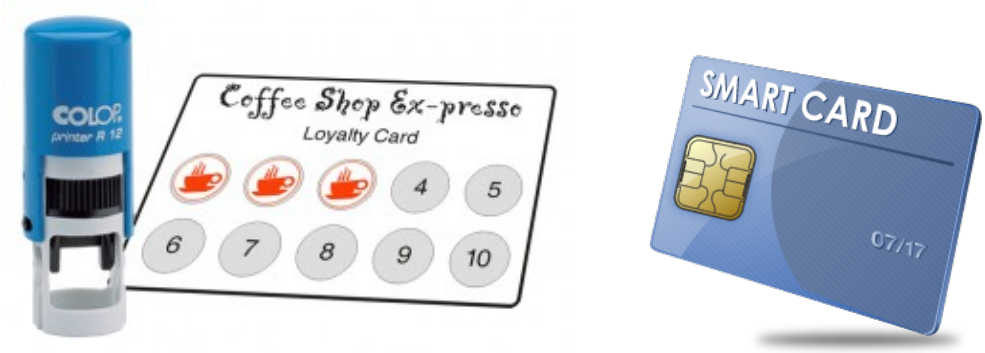

Figure 1.1: A paper stamp card & smart card

1.2 Rationale

The smartphone is now a staple item which many people cannot leave their home without. As of 2014, there is a worldwide user-base of approximately 1.75 billion smartphone devices [1]. Migration to phones allow the business to have a central hub of all of their loyalty schemes, eradicating the need for paper. This means that issues relating to paper-based systems, such as printing paper (environmental impact) and people losing their stampcards are no longer an issue. Moreover, businesses will now have the option to track use and monitor their schemes for further analysis. This grants them insight into how many users they have, allowing them to adjust loyalty schemes appropriately.

On the other hand the proposed solution is not without some problems of its own. For instance, not everybody owns a smartphone, so hybrid smartphone/paper solutions will need to be considered. Additionally, there exists specific disadvantages of smartphones, such as dependence on battery life and an internet connection.

1.3 Aim

The aim of this project is to develop a general purpose solution using a smartphone that supports businesses in creating, managing and deploying a simple loyalty scheme - using gamification elements to engage the users. The specific technology chosen is NFC in phones running the Android operating system.

1.4 Objectives

- Research the state-of-art surrounding NFC technology within loyalty and gamification systems
- Examine and analyse the current smartphone solutions available to manage loyalty systems
- Design and implement our solution
- Perform a field study with the system as an evaluation
- Look into the future possibilities of the system and the infrastructural requirements to support its use in a real-world environment

1.5 Deliverables

The primary deliverables we perceive for this project are two Android applications. A ‘Loyalty Stampbook’ application for consumers to collect, manage and use their loyalty

schemes – along with a 'Loyalty Manager' for businesses/employees to distribute 'stamps' to customers via NFC.

1.6 Significance & Contributions

NFC is a topic rising in popularity. Many new mobile smartphones now have a chip for NFC communication and many businesses are moving their 'card' based services onto smartphones. As such, it is beneficial to explore the possibilities of transferring traditional loyalty cards into the digital era.

Our solution provides a unique paper-less way for businesses to disseminate a loyalty scheme. We attempt to alleviate much of the hassle and cost to businesses with regards to implement

Moreover, we aimed to keep the solution very generic as to allow an element of branding and customisability, as well as using open protocols to extend the system to other mobile operating systems.

1.6.1 Similar Developments

There exist some similar mobile-based solutions to the one proposed, such as Apple's *PassBook*. Passbook is an iOS exclusive application that allows users to save their generic cards (i.e. boarding passes, event tickets, loyalty cards etc.) Though also a general purpose solution, there is a distinction on the technologies used (QR/Barcode Scanning) and the interactions presented to the users - For example, Passbook entails the one-way interaction of simply scanning barcodes. By adopting the two-way possibilities provided by NFC, richer interactions can be built and allow inter-communication between devices. Section 2.2.6 will discuss the advantages and disadvantages of each technology.

Other loyalty applications also exist, some using some combination of NFC or gamification elements; nonetheless they are specific to their associated brand. Starbucks' application on iOS is one such example (Fig. 1.2), offering users a digital QR version of their Starbucks card (Fig. 1.2c) and a medium to collect rewards in the form of stars. These stars, along with the account balance can be used to claim rewards and beverages. The opportunity of our proposed solution is to make an encompassing general-purpose solution that any business, big or small, can use to simply implement a loyalty program.

In the literature survey we shall cover primary technologies and research that enable these developments, along with confirming the need for a general-purpose solution.

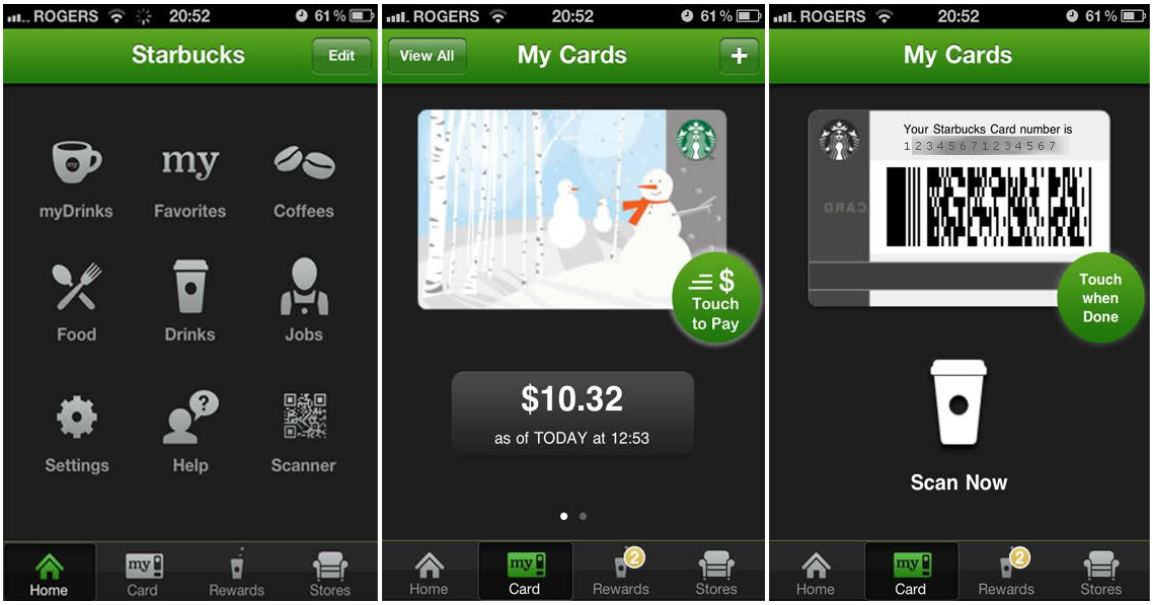

Figure 1.2: Starbucks application for iOS6 (a) The menu of the Starbucks app (b) The card and available balance (c) The bar-code presented to the baristas to scan

1.7 Resources Required

1.7.1 Technologies

Android Platform

Android is a smartphone operating system developed by Google. Along with Windows Mobile OS and Apple's iOS, these three operating systems are the biggest players in the global smartphone market. Android was selected for our system was most devices are equipped with an NFC chip and have well supported APIs regarding Host Card Emulation (See 1.7.1). With the introduction of iOS8, Apple now has support for NFC payments that work with the new iPhone 6; however APIs are unavailable to developers at this time and as a result, cannot be used. Windows Phone has similar NFC libraries to Android, but was not chosen due to it's low market share (2.5% as a pose to Android's 84.7%)[2].

Android SDK

The Android Software Development Kit (SDK) Will be required to develop, implement and test the Android applications. There are several methods that can be chosen regarding Android application development without having to use Google's JAVA SDK. Unfortunately, due to the specific dependencies on Google's NFC APIs, development will need to be done using the JAVA SDK.

Host Card Emulation (HCE)

NFC chips can be placed into Card Emulation mode in such a way (ISO 14443) that a reader classifies it in the same manner as a smartcard.[3]. Implementation of the system is dependent on use of this NFC facet. *Android 4.4 Kitkat* and above support this mode within the APIs.

1.7.2 Android Devices

For most cases of Android development, the bundled emulator with Google's Android SDK is sufficient; however due to the project's dependence on the NFC chip, at least two physical (preferably differently branded) devices need to be used. One will be running the Loyalty Manager, whilst others will be running our Loyalty Stampbook. Both devices must at least have the *Kitkat 4.4* iteration of Android in order to use Host Card Emulation.

1.8 Dissertation Overview

The rest of the dissertation is presented in the following chapters:

Chapter 2 *Literature & Technical Survey* – Here we will introduce the research topics of 'NFC', 'gamification' and 'persuasive technologies' and review their applications to the world of mobile applications.

Chapter 3 *Requirements & Design* – Divulges the process of outlining the design of the system.

Chapter 4 *Implementation* – A detail account of the system was built, along with the novel challenges presented.

Chapter 5 *Evaluation* – A field study with users in a natural environment. We attempt to gather quantitative and qualitative feedback, whilst trying to quantify the impact of gamification within the system.

Chapter 6 *Discussion*

Chapter 7 *Conclusions & Future Work* – A closing discussion for our system and the vision for the future.

Chapter 2

Literature & Technical Survey

2.1 Introduction

This chapter will explore the state-of-the-art surrounding near field communication, gamification and persuasive technologies, along with some current solutions implemented by the industry.

It is anticipated that the main deliverable for this dissertation would be two Android mobile applications to facilitate the creation, deployment and management of a Loyalty Scheme. As such, we will need to discuss the pressing research, benefits and issues that encompass creation of 'sticky' technologies on mobile platforms.

2.2 Near Field Communication (NFC)

Near Field Communication (NFC) is an up-and-coming wireless technology that is currently being adopted in many contexts. Using this proximity-based standard, Two individuals can share data by placing NFC-enabled devices within a few inches of eachother.(see example in Figure 1.1). The standard was first established by Nokia, Philips and Sony in 2004 to define next generation radio frequency communications [4].

Figure 2.1: Using the smartphones NFC chip with a VISA application on a wireless card reader as a form of contactless payment

2.2.1 Technical Fidelity of NFC

NFC is a close relative to Radio Frequency Identification (RFID), using the 13.56 MHz radio frequencies under 424Kbit/s bandwidth [5]; however it operates at a far shorter range (10cm versus 100m). As with RFID, there are two types of NFC devices - powered and unpowered. Powered devices surround themselves with an ultra-low power electrical field, inducing electric potential to other NFC devices within range; whereas unpowered devices (also known as "tags"), rely on this electric potential from powered devices as a power source during the interaction.

NFC devices can adopt several different modes for different interactions [6]

Tag Reading/Writing A powered NFC device in this mode can read and write information stored in tags. Websites, contacts and telephone numbers are commonly encoded in this manner. Upon reading the tag, it is the software's responsibility to act on the data in an appropriate manner [3]

Host Card Emulation NFC chips can be placed into Card Emulation mode in such a way (ISO 14443) [7] that a card reader classifies it in the same manner as a smartcard. NFC devices can keep different cards in storage and switch between emulating them as required. [3]

Peer-to-Peer Two powered NFC devices can bidirectionally share information between each other - for instance Bluetooth pairing information. [3]. In the case of a business environment, authentication can take place between two devices in the same bidirectional manner [8] as a form of 'secure log-in'.

2.2.2 Applications of NFC

Wireless communication technologies such as NFC have been around for some time. Many electrical devices with the capacity to communicate already use Wi-Fi, Infrared or Bluetooth; eventually these technologies make their way into modern smartphones and other domestic devices. Due to the openness of the NFC standard, there are a wide plethora of implementations facilitated by the technology:

• **Contactless Payment/Mobile Wallet** Starting from 2005, banks began integrating contactless chips inside debit/cards for payments under 20 USD/GBP (provided that the card reader supported contactless). From 2011, several large players such as Google, Apple and Paypal have developed mobile wallet applications, with Google and Apple primarily supporting NFC. Contactless cards too rely on the (ISO 14443) [7] smartcard standard, complementing the previously discussed host card emulation, allowing an NFC chip to emulate an identical smartcard. Whereas, contactless debit and credit cards are prevalent, Google Wallet and Apple Pay are not available outside of the US Market, reasonings being ill-documented.

• **Ticketing** Contactless ticketing has been available for a while, the Oyster card[9] being an iconic example; nonetheless it has the issue of being a proprietary, locked down technology. In 2014, contactless cards were enabled within the system. Some argue that the goal of removing cash-payments was a driving factor of the acceptance of contactless ticketing [9]. Moreover, Host Card Emulation infers that mobile wallet applications would also be able to take advantage of these readers.

• **Gaming** Game designers have always looked for ways to make video games more engaging. There are two methods in which they can implement NFC within their games, with the intent to make **Pervasive Games**. Such games expanding the play space into the player's ordinary social life [10]. Firstly, they may may use NFC to enrich collaboration and sociability. As an example, a study was done with two identical games, one with NFC and the other without[11]. Experiments were ran with two groups of individuals and findings showed a sharp increase in positive experience for NFC over touchscreen [11]

The second and more recent way NFC can be implemented in video games is through physical-digital mappings. The *Wii U* [12] video game console contains an NFC chip in the controller, allowing users to use NFC enabled figurines on the controller. The result of tapping these devices together makes figurines appear within the console as in-game characters.

• **Loyalty Schemes** Loyalty using NFC is a topic that is still being explored by industry. As such, there are some different and creative implementations available. The original NFC Loyalty solutions came in the form of staff/store cards; however with the advent of NFC in

mobile phones, pervasive solutions have been implemented such as *Orange EAT* [13]. In this scheme, consumers can tap specific NFC posters and tags in order to gain free rewards in the form of food and drink [14]. Unfortuantely this promotion was unsuccessful as at the time only 200,000 customers had an NFC enabled device on Orange (less than 1% of the total customer base) [14]. There are several other prototype solutions available; nonetheless they were not properly adopted as NFC was not available on enough phones.

2.2.3 NFC in Phones

NFC functionality in phones is actually not a new concept; phones with NFC chips have been around since 2006, but the adoption of NFC with manufacturers did not get popular until 2010 when a set of peer-peer standards were released to transfer useful information (contacts, URLs and bluetooth) [8]. Since then, popularity took off, with IHS[1] predicting that 939 million NFC enabled handsets would be shipped in 2018 (Fig. 2.2) [15].

World Shipments of NFC-enabled Cellular Handsets

	2013	2014	2015	2016	2017
Millions of Handsets Shipped	275	416	575	797	939

Source: IHS Inc., February 2014

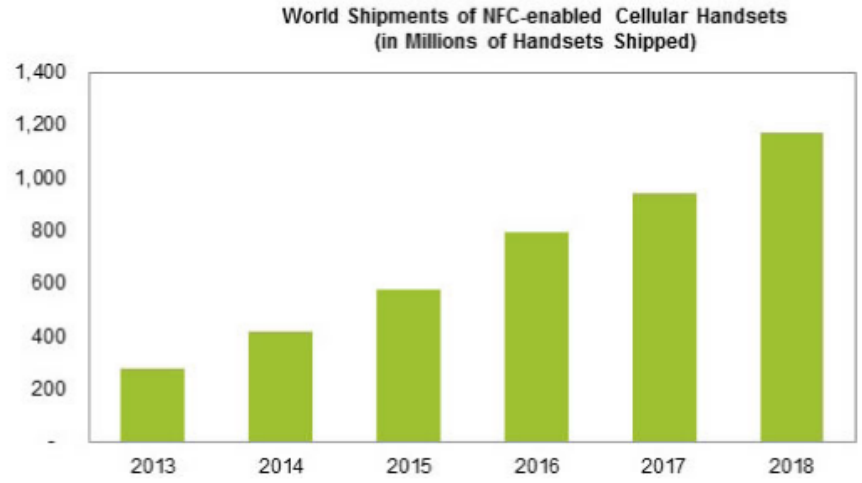

Figure 2.2: A chart depicting the predictions of mobile phones shipments that have NFC built-in

Interestingly, of all the applications mentioned in the above section, **all** of them have been implemented both with and without mobile phones. The advantage of using the mobile phone is that it has the capability to consolidate a potentially infinite amount of NFC cards, tags etc into just one chip.

Software support for NFC is something that must be accompanied with hardware. Android and Symbian implemented software support in 2011, Microsoft in 2012 and Apple in 2014. The fact that these implementations are very recent can be attributed to the rising popularity of NFC.

[1] IHS inc is a data and critical information provider for the technology industry

2.2.4 Areas of Research

In 2010 a survey was done of academic papers surrounding NFC [16]. The authors gathered a total of 74 research papers and used content-oriented classification [17] in order to split up NFC papers into four categories: NFC Theory, NFC Applications, NFC Infrastructure and NFC Ecosystem. The results of their findings are shown in table 2.1.

Classification	Description	Number of Papers	Percentage
NFC theory and development	The concepts and developments of NFC, along with future recommendations and ethics	15	**20.3%**
NFC Applications and Services Reader-Writer Mode Applications Host Card Emulation Applications Peer-to-Peer Applications	Discussing or developing different implementations of NFC applications and services based of NFC modes	30	**40.5%** 25.7% 13.5% 1.35%
NFC Infrastructure	Types of NFC technologies and their applications in the real world, also security and privacy	22	**29.7%**
NFC Ecosystem	frameworks for businesses that want to integrate NFC culture & models and strategies into their processes	7	**9.5%**

Table 2.1: Table showing the primary categories of NFC research

It can be observed that a huge proportion of NFC literature (40%) at the time was heavily focused on developing prototype applications and services. However, the specific types of applications were primarily 'Reader-Writer' mode as this was just before the introduction of NFC peer-to-peer standards.

The research identified that there was a gap in researching the development of NFC principles and theories or how to integrate such solutions into business models. As a result, we can argue that this business-orientated business gap was a factor for the slow adoption of NFC.

2.2.5 Limitations of NFC

The key limiting factor of NFC for the longest time was the slow adoption rate by businesses and manufacturers. Contactless payment, the predominate form of NFC interaction depended on specific NFC card readers to enable contactless functionality; furthermore we cannot underestimate the amount of effort it takes to introduce a new billing option to a country.

Analytics also show that NFC implementations are very fragmented with no apparent standard protocols [18]. This can be attributed to two reasons: the openness of the NFC platform encouraging different implementations and businesses wanting their own implementation for their own needs. For instance, in the example of loyalty schemes, each business might have a separate loyalty application which the customer needs to download and setup. These applications allow businesses to perform their own tracking and branding.

2.2.6 NFC vs Quick Reference Barcodes

Another technology considered for communication was *Quick Reference (QR) Barcodes* (Fig. 2.3). These convey information through a 2D code matrix which can be scanned by a barcode reader or optical camera. A summary follows of the advantages and disadvantages of each technology [19][20]:

Figure 2.3: An example of a QR code

Analysis of QR

The advantages (+) and disadvantages (-) of QR are:

+ QR Codes can be cheaply printed on paper. No tags need to be involved.

+ Smartphones need only a camera and QR Reader application to interact with the technology

+ They are generally seen as more secure as they exist outside of a mobile operating system, making them less vulnerable to exploitations.

— Reading a QR code is a much slower interaction as it requires an actor to have a camera app open to scan the barcode.

— QR code scanning is generally seen as one-way interactions as barcode readers have no way to communicate with the barcode (physical/digital).

— QR codes cannot hold dynamic information. In order to change the sent message, a new barcode will have to be generated

Analysis of NFC

The advantages (+) and disadvantages (-) of NFC are:

+ NFC Interactions are much simpler and faster as they only involve a tap
+ NFC chips can dynamically change their contents without having to generate a new tag/device
+ NFC affords compatibility with many standard smartcard readers
+ Two-way interactions are possible, where both NFC chips can communicate with each other in duplex.
— Requires NFC enabled smartphone in order to operate
— cannot simply be 'printed out on paper' – an NFC tag must be purchased
— very short range of NFC makes it difficult to eavesdrop on; nonetheless it is still possible

Research

Many researchers [21][22][23][24] provide conflicting opinions regarding which of these technologies should be mass adopted. As NFC chips have taken a substantial amount of time to be integrated into modern smartphones, QR codes were embraced by many businesses as many smartphones can display/read them. On the other hand, the commonality of NFC in modern smartphones narrows this gap in availability. Some solutions have chosen to overcome this gap by creating hybrid systems that support both technologies [25]

Justification for NFC

For our system, speed over availability is needed as we want the interaction to be at least as fast as stamping a paper card. A system like this cannot afford to complicate such a simple interaction; therefore we confirm the viability of NFC as our chosen communication technology.

2.3 Gamification

Over the years, a keen topic of research within Human Computer Interaction is that of user engagement. There are several different design models that afford this goal. One recent and popular example being gamification.

Gamification can be best described as

> "An informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement." [26, p. 2425]

The need for gamification comes from the modern zeitgeist of the digital world, a world of engagement. Comparing the current opportunities for entertainment (i.e. video games, social media, the internet) to those from fifty years ago, provide users with much more choice. Furthermore, users are no longer registering traditional advertising in the same way they did fifty years ago. A study done with university students using eye-tracking technology with *Facebook* shows that students perceive less than a quarter of the site's adverts [27]. Experimenters concluded that this was due to users scrolling the timeline too quickly and learning where advertisements appear, therefore ignoring those areas.

By harnessing the power of play, designers can apply motivational affordances to improve user engagement. Gamification techniques are predicted as the future of marketing [6], with Gartner[2] stating that 50% of companies with innovation processes will incorporate gamification by 2015 [28].

2.3.1 History

The principles of "turning things into games" are actually not new. They have long been employed by parents and teachers to make activities seem more enticing to children; however applying game-like aspects to a business environment was only formally introduced in the 80's [29]. The word *Gamification* was coined in 2002 by Nick Pelling, an early computer games programmer that wanted to apply game-mechanics to different contexts [30]. Recently, gamification has become a buzzword amongst modern system designers. The rise in popularity can be shown in a Google Trends search (Fig. 2.4). This boom can be attributed to soaring video game popularity and cheap enabling technologies found in modern domestic appliances (i.e GPS, Internet Access, Bluetooth etc.) [31]

[2]Gartner is an IT research and advisory business

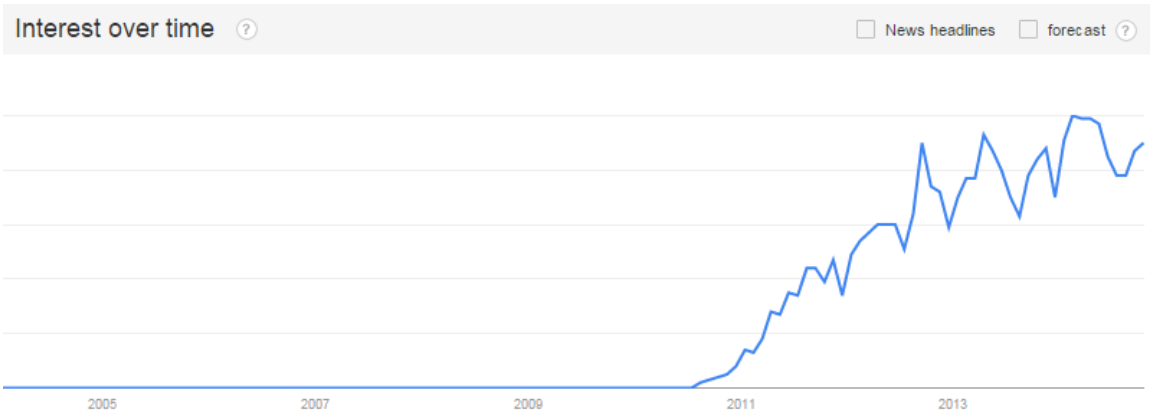

Figure 2.4: Google Trends graph depicting the search popularity of the term **Gamification** over the years

The use of gamification has also shifted over the years. Many reseachers [32][33] consider Charles Coonradt as pioneer in the field of gamification. In his acclaimed book *The Game Of Work* [29], Coonradt introduces "game-like concepts" inspired from sports as a means to increase employee productivity, satisfaction and motivation [29]. On the other hand, gamification in the digital age takes inspiration from video games to to improve user experience, engagement and loyalty. [6]

It can be argued that the two inspirations (sports vs. video games) present us with different flavours of gamification. Games of sport entail clear goals, instantaneous feedback, and the concept of striving to be better. Video games aim to keep players playing by providing psychological rewards such as achievements, unlocks and ability to compare their skill with their friends. Even though these two methods of gamification have some differences, their main shared trait lies in the way they play on our natural instinct of socialisation and competition. [34]

2.3.2 Gamification and Mobile Technologies

Although elements of gamification can be found in a variety of systems, mobile technologies have seen biggest boom in gamified systems. As mentioned earlier, a major contributer to this boom is the prevalence of cheap enabling technologies such as bluetooth, and GPS - all of which can be found on a modern smartphone. In 2009, Foursquare was one of the first successful gamified mobile applications; allowing users to "check-in", collect badges and receive recommendations on where to go next [35]. Five years later, Gartner predict that 70% of the top 2000 companies would have a gamified application by the end of 2014. [36]

2.3.3 Areas of Research

A survey was done of academic papers in 2014 analysing gamification [37]. 24 Papers were gathered that involved empirical studies to answer the question 'does gamification work?'. Papers were broken down by gamification elements (shown in Table 2.2) and system purpose (shown in Table 2.3)

Motivational Affordance	**Papers Containing**
Points	9
Leaderboards	10
Acheivements/ Badges	9
Levels	6
Story	6
Theme	4
Clear Goals	6
Feedback	6
Rewards	4
Progress	4
Challenge	7

Table 2.2: Table containing the how many papers referenced certain gamification techniques

It is easity identifable that points, leaderboards and badges are the most commonly implemented techniques. This can be attributed to social media, as these three affordances are ideal for competition between friends. Interestingly, not very many papers referenced rewards, which may not be as strong of a motivator as competition.

Application	**Papers**
Commerce	1
Education	9
Health	1
Organisational	4
Sharing	1
Sustainable Consumption	1
Work	4
Innovation & Ideation	2
Data Gathering	1

Table 2.3: Research papers broken down by system purpose of analysed implementations

True to the roots of gamification, many analysed systems were used in an educational manner. On the other hand, many other applications seem to be vastly unexplored, including commerce and work which are the contexts of our system – hinting a gap in the market gamification for those areas.

2.3.4 Critiques of Gamification

The application of gamification practises to digital applications is prevalent amongst business applications [36], nonetheless these practises have attracted criticisms. One view adopted by the video games industry is that gamification mistakenly portrays "game-like" properties, such as levels and scores as part of human behavioural complexity. [38]. Moreover, there are negative "exploitative" connotations (discussed later) to word gamification in the business world; therefore businesses generally prefer the term "motivational design" instead.

The concept of creating "sticky" systems via gamification techniques can also present us with systems that affect user behaviour negatively. The McDonalds Monopoly sweep-stake is a well known example of this phenomenon. The promotion involves the collection of monopoly stickers containing prizes from purchasing certain food and drink (more stickers with larger meals). Paxman et al [39] introduce examples where consumers change their purchasing habits in order to maximise the number of stickers they receive, linking these changes to childhood obesity [39]. Several theories of motivation exist explaining these behaviours; however Zichermann [35] considers motivational factors as unruly, yet admits "once you start giving someone a reward, you have to keep [them] in that reward loop forever" [35, p. 27].

2.4 Persuasive Technologies/Captology

Capturing the attention of an person for the purposes of persuading them is a problem that sympathises with many. Businessmen, politicians and teachers alike are examples of such professions - more specifically professions where persuasion is an integral factor of their success. There exist a plethora of methods to achieve this, for instance salesman study marketing, politicians study public speaking, whilst those in the realm of technology study captology (the art of persuasive technologies).

We can define 'persuasive technologies' as:

> Solutions which are designed with a purpose to change attitudes or behaviours via persuasion and social influence, but not through coercion [40][p.10]

Fogg, considered by many [41][42] as a pioneer in the research of captology, identifies the art as an intersection between technology and persuasion (Fig. 2.5).

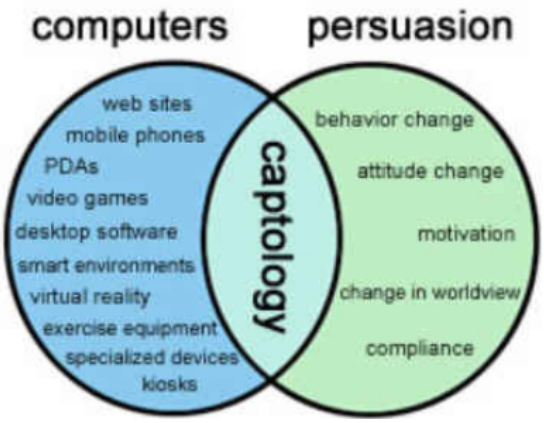

Figure 2.5: A Venn diagram showing the intersection of persuasion and technology - Captology

2.4.1 Types Of Motivation

It is also helpful to mention the types of motivations which affect people to do activities. Literature indicate that there are three main types of motivators that drive people to behave in a certain way, Deci and Ryan [43] define them as:

Extrinsic Motivation Incentives where motives to enact the task are not related necessarily to that specific behaviour - *i.e. Completionism*

Extrinsic motivation takes the form of leveraging the human Psyche. For instance, the example of a progress bar persuades the user to bring it up to 100%. The user may not be specifically motivated to perform the task, but they are motivated to complete the progress bar.

Intrinsic Motivation The act of making the intended behaviour so pleasurable that it becomes an end in itself - *i.e. Gamification*

The philosophy of this motivator is to persuade the user to engage with the activity in a way that they enjoy. Gamification exists within this realm of motivation, making activities more enticing to users.

Tangible Motivation External Incentives driving the motivations - *i.e.Rewards/Money*

These motivators usually offer some sort of reward such as money to entice the user to perform an action. Although only considered as short-term, it is useful at incentivising one-off activities that are difficult to make engaging, for example surveys.

Persuasive technologies afford the use of any combination of these to develop systems. We discuss an example in Sec. 2.4.3

2.4.2 Fogg's Taxonomy

Fogg characterises each persuasive technology by *functional roles*: tools, media or social actors. [44], of which technologies can identify as one or several of these categories. The proposed triad is designed to model the way in which users see and react to the following:

Tools These technologies are designed to make people's jobs easier[40]. For example a wizard or an Out of Box Experience (OOBE) can give users direction regarding the completion of a specific or complex user task.

Media Media-centric technologies are designed to provide users a platform to create experiences that develop, teach or enforce a behaviour. These can come in the form of games, interactive systems or stories; the best examples however are simulations. Simulations place the users in a specific environment where they must interact with rules of the system in order to hone a required set of behaviours; such behaviours can be for the purposes of testing or real-life skills.

Social Actors With the introduction of social actors, computer systems can now influence users using social cues. Actors can be persuasive by giving a human face to positive feedback, modeling an inded behavior or provide moral support to the user [40]. The *Microsoft Paperclip* is a famous example of a social actor to teach users how to use Microsoft Office. Research in this area is constantly developing as it's difficult to build 'human' characters without entering "uncanny valley".

2.4.3 Persuasive Technologies Through Gamification

Persuasive Technology is a broad term. As such, it can be argued that gamification exists within the realm of captlogy; nonetheless there exists the key differentiators of scope, more specifically - gamification is not necessarily linked to technology (although 'gamified' technologies are generally more common).

A well known case study of implementing persuasive technologies using gamification are The Piano Stairs (Fig. 2.6) [45]. In this example, tiles and speakers in the configuration of a piano were installed next to an escalator, each stair playing a specific note on the piano when stepped on. The purpose of this experiment was to get more commuters to take the 'healthier' stairs rather than the escalator. Results showed that people were taking the stairs frequently and in more 'musical ways', with some musicians attempting to play songs using them. There was however another factor that encouraged people to take the stairs: curiosity [45]. The staircase is so out of place that people are curious and thus want to explore and engage with the technology.

Figure 2.6: The piano tiles staircase

Applying the concept of Fogg's taxonomy and motivator types, this innovation is an example of a media-oriented technology, fueled by intrinsic motivation - making the act of going up the stairs more enjoyable. Although empirical evidence on users after taking the stairs was not tracked, it would be interesting to see whether these stairs impacted people's choice of taking other stairs in the long run.

2.5 Survey of Technologies

We now turn our focus to the developed solutions. These technologies were chosen as they use a combination of NFC, gamification or persuasive technologies. The first group will contain implementations dedicated to a certain business; whereas the second will look at more generic applications. The chosen solutions were only those where **Loyalty** was the core function of the technology, 'ecosystem-based' combined solutions were not considered.

In order to summarize these technologies later, each of the following should answer these questions:

- How does the user interact between the real world and the applications (what pervasive elements does the application possess)?
- What elements of gamification exist?
- In what ways are multiple loyalty schemes presented?
- Are there any subtle persuasion techniques employed?

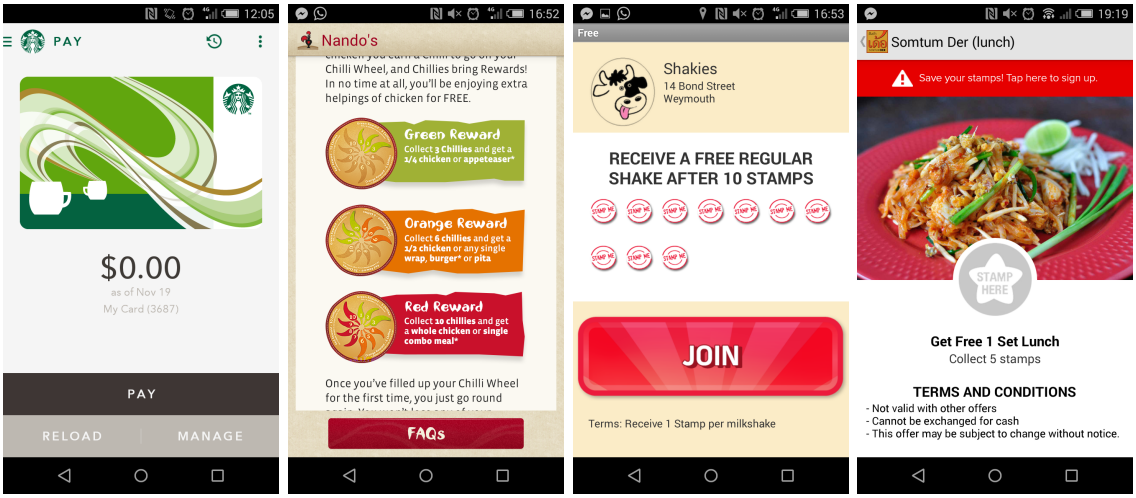

Figure 2.7: The technologies to be analysed: (a) Starbucks (b) Nandos (c) StampMe (d) Stamp

2.5.1 Starbucks Mobile Application

Overview The Starbucks mobile application is designed as a digital-companion to the standard plastic loyalty card they provide. The application allows user's to either have a digital-only card or transition their physical cards onto the app, allowing customers to view, top up and pay with their balance.

What are the pervasive elements? Aliased Card Using BQ barcode that is scanned by a barista.

What elements of Gamification exist? Collect Stars with each purchase, free drink on 15, upgrade to gold member upon collecting 50 stars.

In what ways are multiple loyalty schemes presented? The user can have up to 10 Starbucks cards but only claim free drinks with their stars.

Are there any subtle persuasion techniques employed? Extrinsic Motivation of filling a cup, personalise your card.

2.5.2 Nandos Mobile Application

Overview As with Starbucks, the Nandos' mobile application works in a very similar manner to the starbucks card. It allows users to register their current physical card; however this app is purely as a companion, informing users of the status of their loyalty points in the card.

What are the pervasive elements? There are no pervasive methods. The user must have and use a Nandos Card.

What elements of Gamification exist? No elements of gamification are used.

In what ways are multiple loyalty schemes presented? Loyalty schemes are presented as a progressive stampcard. Rewards of increasing value are granted upon reaching certain amounts of chillis

Are there any subtle persuasion techniques employed? When a users connects their card to the app, A wheel with different colored chillis are displayed. In order to get rewards, users must complete the wheel, displaying the example of extrinsic motivation via completionism - encouraging users to fill the wheel.

2.5.3 StampMe & Stamp

Overview StampMe & Stamp are both general purpose loyalty application for corporates to implement loyalty schemes. Businesses can only have one loyalty scheme that mainly adopts the "free x with y stamps" methodology. Users can browse for nearby shops that have available offers and collect numerous schemes.

What are the pervasive elements? In order to gather a stamp from these apps, the business uses a proprietary digital stamping device to stamp the screen of the mobile phone, thus transferring a stamp. Although this is an interesting way to stamp the screen, information about the specific technology it uses proved impossible to find. It can however be inferred that this technology is not NFC as it works on both iOS (those with and without NFC chips) and Android.

What elements of Gamification exist? no offers or gamification elements are implemented within these applications.

In what ways are multiple loyalty schemes presented? Once a user 'joins' a business' loyalty scheme, it is added to a list of their current loyalty programs. The list is made out of simple text and does not display any information about the progress of the schemes - unless they explicitly click on the name of the business first.

Are there any subtle persuasion techniques employed? These applications attempt to clone a real Stampcard. This is considered a use of extrinsic motivation where users may not necessarily want to buy a coffee but want to complete their stamp card.

2.5.4 Summary of Solutions

We summarise the fidelity of the above systems into table 2.4.

	Pervasive Elements	Gamification Elements	Multiple Schemes	Persuasion Techniques
Starbucks	QR Code	Collecting Stars	None	Fill up cup with stars for a free drink
Nandos	None	None	Can claim different rewards depending on amount of built up chillis	Fill the wheel to increase chilli count
StampMe & Stamp	Proprietary System	None	Add multiple loyalty schemes from participating businesses	Affordance of real stampbook appearance

Table 2.4: A summary of the solutions discussed

Although there exists some general purpose loyalty solutions, they lack the polish and compared to the business-centric applications. On the other hand, those applications that are business-centric require users to install a mobile application for each loyalty card. Whereas large businesses have the resources to create such highly customised, high-fidelity systems, small businesses have little incentive to invest outside of paper-based solutions, mainly due to large development and implementation costs. As a result, they usually invest in the underused general-purpose solutions.

NFC with social elements is an area vastly untapped by businesses, mainly due to the slow uptake of NFC by the market; moreover it seems like those loyalty systems using the proprietary stamping technology seem to be re-inventing the wheel instead of using the open standard.

2.6 Conclusions

In this chapter we covered the concepts of NFC, gamification and persuasive technology in terms of research and current implementations. By analysing similar systems, we justify the need for our system as an encompassing general-purpose solution that any business, big or small, can use to simply implement a loyalty program and push it out to any users of the application; collecting 'stamps' using NFC. All loyalty schemes will be automatically incorporated into a gamification framework provided by the application, providing businesses a gamified loyalty scheme with minimal effort.

The next chapter discusses how we identified the system requirements and the process reaching a complete design for the system.

Chapter 3

Requirements & Design

3.1 Introduction

As discussed in previous chapters, the proposed software solution takes the form of two mobile phone applications. This chapter describes and outlines the requirements for our software solution. Requirements will set goals for the functionality of the software, whereas the design section allows us to translate these requirements onto paper. Both sections will become useful when testing whether the system is fit-for-purpose.

3.2 Requirement Engineering

One of the most important activities in software engineering is to specify the software. In this section, system requirements will be presented. Two sources of requirements were used: firstly using information discovered from the literature and technology survey; and secondly from an interview with a project manager at 'Company A'[1]. These requirements are not to be used as an exhaustive list, but are to be used as a benchmark for ensuring the created product is fit-for-purpose.

3.2.1 The Interview

To gather business oriented requirements, an interview was conducted with a project manager, specialising in IT implementations for corporate facilities in Company A. Several points discussed were integrated into the system as requirements. The full transcript of the interview can be found in the appendix A. For instance:

Q6. What do you think of this solution? [The corporate loyalty app]

A. For this solution to be feasible and useful, it would need to be:

- Available for all of our permanent staff to use
- Easy integration for further sites and users globally
- Good usability aspects. Company A has 100,000 staff members with a variety of demographics, therefore all users should find it easy to use and better than the existing process
- The system would need to increment on a daily basis when the staff members enter site (once a day only)

Informed requirements M2, S2, S4, and C6 (explained in the next section).

[1]Company A is a large multinational organisation employing over 100,000 people across 168 countries

3.2.2 Requirements

Our solution involves the creation of two Android applications, thus the requirements below will be marked whether they are for **Both** or exclusively for the **Loyalty Manager**, or **Loyalty Stampbook**. Effort will be made to maximise requirements that encompass both applications.

We found that there was an abundance of potential system requirements, however not all can be implemented in good time. For this reason, we present these requirements in MoSCoW prioritisation format [46] (Must Have, Should Have, Could Have, Won't Have) in order to categorise the importance of their delivery.

Must Have

'Must have' requirements are the minimum amount of features to be satisfied for the success of the system. As a result, these are of highest priority. Requirements defining gamification are not listed here as they are not 'key' to the system.

M1 **Sign-In & Registration**
The user should be able to sign in with an existing account or register for a new one
[Both Systems] — Functional

M2 **Fast Stamping**
Access to the NFC stamping functionality should be available within a single tap from a home page
[Both Systems] — Functional

M3 **NFC Transmission**
The system must use NFC for data transmission and Host Card Emulation
[Both Systems] — Functional

M4 **Online Syncing**
The system must be able to sync a users 'stampbook' online
[Both Systems] — Functional

M5 **Sync on Interaction**
Syncing must take place as soon as there is an interaction that affects the stamp count of a scheme
[Both Systems] — Functional

M6 **Syncing Time**
The response time for syncing must be within 5 seconds
[Both Systems] — Non-functional

M7 **Feedback on Interaction**
The system must provide audio/visual feedback whenever a 'stamp' has taken place

[Both Systems] — Functional

Should Have

The "should have's" represent features which should be included if the system if time permits. Generally these requirements add a layer of usability and engagement to the system; as such, most of the gamification implementation is defined here.

S1 **Consistency**
The system should fit within the standards and design language of the Android operating system
[Both Systems] — Non-functional

S2 **Rewards Browsing**
The user should be able to easily browse their rewards available
[Loyalty Stampbook] — Functional

S3 **Badges**
Users should be able to collect badges upon completing certain goals
[Loyalty Stampbook] — Functional

S4 **Secure Communications**
NFC Communications between devices should be encrypted
[Both Systems] — Functional

S5 **Level-Restrictions**
Rewards should have a minimum-level required in order to claim
[Loyalty Stampbook] — Functional

S6 **Levelling System**
Users should be able to level up each of their loyalty schemes independently (20 - gold, 50, platinum)
[Loyalty Stampbook] — Functional

Could Have

These requirements represent bells-and-whistles requirements. Features in the 'could have' are desirable but not a necessity to the project's initial builds. Incorporations of these requirements into future builds of the system would greatly benefit user experience.

C1 **Passive Card Emulation**
The system could allow passive host card emulation
[Loyalty Stampbook] — Functional

C2 **Branding**
The system could provide deep customisation options for each scheme
[Loyalty Manager] — Functional

C3 **Internet-Free Stamping**
Users could have the ability to gather stamps without being connected to the internet (facilitated by the Manager)
[Loyalty Manager] — Functional

C4 **Multiple Device Support**
Users could be able to login and use multiple devices seamlessly
[Loyalty Stampbook] — Functional

C5 **Personalisation**
The system could allow users to customise the appearance of their profile
[Loyalty Stampbook] — Functional

C6 **Restricted Schemes**
The system could allow for account-specific schemes (only authorised users have access to the scheme)
[Both Systems] — Functional

C7 **Transaction History**
The system could have a transaction history to allow users to see their recent activity
[Loyalty Stampbook] — Functional

Won't Have

'Won't have' requirements are simply outside the scope of the project. Their functionality is either not the purpose of the system (W1), or facilitate unwanted features into the ecosystem (W2).

W1 **Payment Options**
The system will not facilitate any form of payment
[Both Systems] — Functional

W2 **Loyalty Sharing**
Users will not be able to transfer stamps between friends/accounts
[Loyalty Stampbook] — Functional

3.3 Design

3.3.1 Outline

Turning our attention to the design, here we present the system, matching the requirements, outlining how they meet the system requirements. Some interesting scenarios have been mentioned in the requirements that leave a wide scope of design challenges. A study is also undertaken that involves participatory design as an extension of the proposed design - in effect, asking potential users to tackle these challenges.

3.3.2 The Three Components of the System

As mentioned earlier, the proposed system involves two separate applications. However, in order to meet functional requirements M1, M4, C4 and C6 a database will need to be introduced in order to interconnect user accounts, along with any relevant data (i.e. loyalty schemes, stamps and badges). Furthermore, a database is also useful from a security and continuity standpoint. For instance, backing-up stamps and schemes allows users to sync their accounts between phones, as well as preventing the system from abuse of local files.

3.3.3 Modeling The Interaction

The key design challenge of the system is to ensure seamless and correct communications via NFC between each of the three system modules. As outlined in the literature survey, there are several modes that NFC can adopt [47], each changing the device's role as part of the interaction. In this case, Host Card Emulation (HCE) and NFC Readers can be setup in different configurations to facilitate these communications. Two such configurations were considered - Loyalty Manager using HCE and Loyalty Stampbook using HCE (Fig. 3.1). The difference between these configurations is small; however they each have distinct implications.

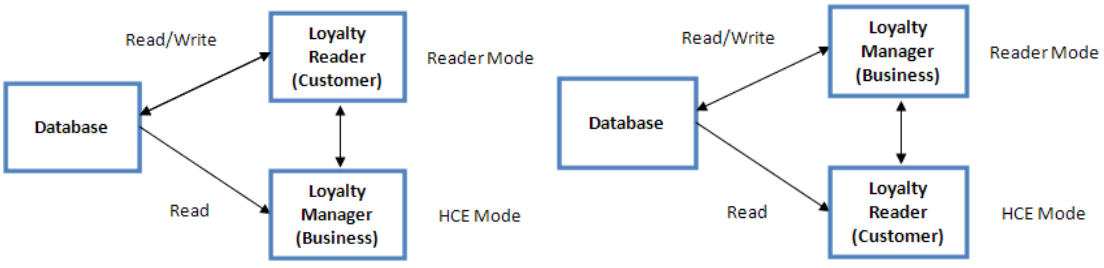

Figure 3.1: (i) Loyalty Manager using HCE. (ii) Loyalty Stampbook using HCE

Loyalty Manager using HCE

Loyalty Manager with HCE entails using the Manager application as a smartcard. In this case, the Loyalty Stampbook interfaces with the database to update the user's Stampbook.

The benefits (+) and drawbacks (-) of this configuration are:

+ Syncing is not necessary as the Manager will always have the updated Stampbook
+ Less logic required in the Applications to direct stamps
— Dependant on both applications having internet connection
— The user must have the Loyalty Stampbook open to collect stamps
— Data integrity issues if people maliciously modify code of the Loyalty Stampbook
— Differentiating between reward & stamp requests is difficult

Loyalty Stampbook using HCE

When the Loyalty Stampbook acts as the smartcard, several interactions differ. Primarily, the burden of dealing with the database is placed onto the Loyalty Manager.

The benefits (+) and drawbacks (-) of this configuration are:

+ The Loyalty Stampbook does not need to have the application open to collect a stamp, the phone functions as a passive smartcard.
+ Only the Loyalty Manager needs access to the internet. Customers will be able to collect and expend stamps whilst not connected
+ The Loyalty Manager can easily separate stamp requests from reward requests
+ Data is more secure as only the authorised Loyalty Manager has access to modify the database. Ultimately, this prevents user tampering and ensures data integrity within the system
— Complex logic required in both applications
— Providing specific feedback directly to the Loyalty Stampbook via the app is difficult

Chosen Model

Loyalty Stampbook using HCE was selected on the merit of its positives. Primarily, not requiring internet access from the customer, the ability to collect stamps without having the application open and its emphasis on security. On the other hand, it makes the implementation challenging, requiring more logic to support the two-way communications. Nonetheless, we expect that this model will ultimately benefit the system by making it easier to use and understand for users.

User Feedback

Requirement M7 identifies the need for user feedback in both applications when stamping. Mobile operating systems provide several design patterns to accommodate interaction feedback, for instance: audio, notifications and haptic/vibration. For the Loyalty Stampbook, notifications were selected as the **primary** method as users may want to keep their phones on silent. Within the Loyalty Manager, responses can be presented as a simple popup[2]. Moreover, we integrate an audible sound whenever two NFC devices make contact; however users will be able to mute this feature if the device is placed on silent.

3.3.4 Design Methodology

In order to develop the designs for the system components, a user-centered design[48] approach was taken for each iteration. The initial wireframe was mocked-up from Android design heuristics as a design language.

Design Language

In order to identify the deign language for our system, guidelines to be defined. Usability consultant Jakob Neilson presents ten usability heuristics for interaction design. One such heuristic is 'Consistency and Standards' [49], in this case meaning that the solution should follow the platform conventions and design of our operating system. This satisfies the requirement S1. It is important to highlight that users of our applications are also users of the mobile operating system – Therefore, if this heuristic is met, users will feel more comfortable with the system as it will feel familiar to use. *Material Design* [50], is a visual design language from the Android OS with a goal to:

> *"Develop a single underlying system that allows for a unified [user] experience across platforms and device sizes"* [50, Introduction]

We present the designs to potential users within our target users (age 16-40). Feedback was captured, analysed and incorporated into the next iteration. In the interest of time, two iterations were incorporated for the Loyalty Stampbook and one for the Loyalty Manager.

[2] 'Toasts' are used to achieve this in Android as a form of simple feedback

3.3.5 Design Process - Loyalty Stampbook

Wire-Frame Mockups

The wire-frames were developed on paper using the Material Design guidelines discussed earlier (Fig. 3.2). An analysis of the design decisions follows:

Figure 3.2: The initial wire-frame mockup for the Loyalty Stampbook using the Material Design guidelines

1. 'Pips' are a common design pattern on mobile devices. They serve as a page indicator and afford swiping on the screen. In this case, users can see all of their loyalty schemes in this page and can swipe between them.
2. The idea of having 'loyalty cards' is a metaphor from the real world. Businesses may be able to customise the graphic on the card. Cards on mobile screens also afford flipping over for more information - within mobile applications this is done via a tap, meaning users can get details of a loyalty scheme by tapping the card.
3. Floating Action Buttons (FAB) are special buttons used to present users with the primary action of the application. In this case it is a stamp button that takes users to the stamp screen.
4. A list of available rewards for the users, notifying them which rewards are available.
5. A stamp screen to notify the users to tap their device onto the reader. Within this design, all NFC interactions are done with this screen open; however this screen may not be needed using the Loyalty Stampbook using HCE interaction model

Feedback For Next Iteration

The design was present to three potential users individually, a list of suggestions follows:

- *"If it is so important, shouldn't the stamp button should be in all pages, not just the*

home page?"

- *"How will gamification work in the design?"*

Paper-based mockups are fast and cheap way to prototype a design; however they can make it difficult to communicate links between the actions; Nonetheless, user suggestions were considered for the next iteration.

Iteration 1 - Mockup

The first iteration was a near direct translation of the paper wire-frame into a navigable mockup (Fig. 3.3), with a few small changes following previous feedback. A dedicated loyalty scheme page was introduced to track potential gamification concepts (fulfilling requirement S3), along with the addition of a stamp button on every page.

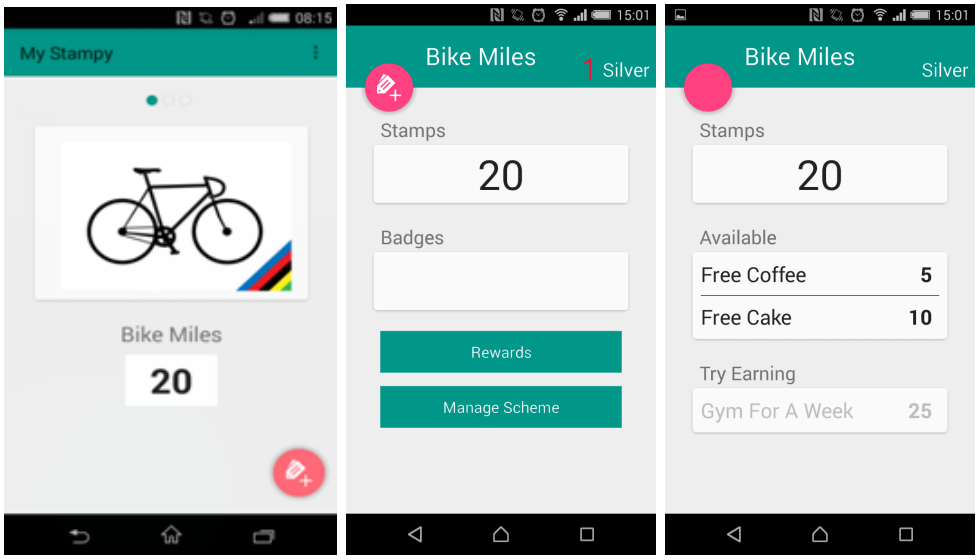

Figure 3.3: A mockup of the wire-frame incorporating suggestions from last iteration

1. A dedicated loyalty scheme page for the user to explore the current loyalty scheme. These may be customisable for the business. Potential gamification methods, such as levels and badges would live here if implemented.

Feedback For Next Iteration

The design was present to three potential users individually, a list of suggestions follows:

- *"If I have many loyalty schemes, It feel sluggish to scroll through all of them individually. Perhaps have them as a list"*
- *"If I have my own account, there should be a profile page"*

- *"It takes too many clicks to get to the rewards"* [2 clicks after finding scheme]
- *"The stamp button makes me thing I'm only stamping the visible scheme?"* [This was an unintentional consequence of the design]
- *"The app shoulds tell me when I have sufficient stamps to claim a reward"*

More issues were identified during this iteration as users were able to explore the design effectively. Nevertheless, feedback clearly suggested that this design was slow, confusing and ultimately - not fit for purpose. Substantial changes had to be made.

Iteration 2 - Final Design

In order to remediate some of the design problems identified with the previous feedback, a very different approach had to be taken with the design - as presented in Fig. 3.4. In order to present clarity, several user interface aspects had to be removed; for instance the stamp button was removed and is to be replaced with instructions on how to stamp upon logging-in for the first time.

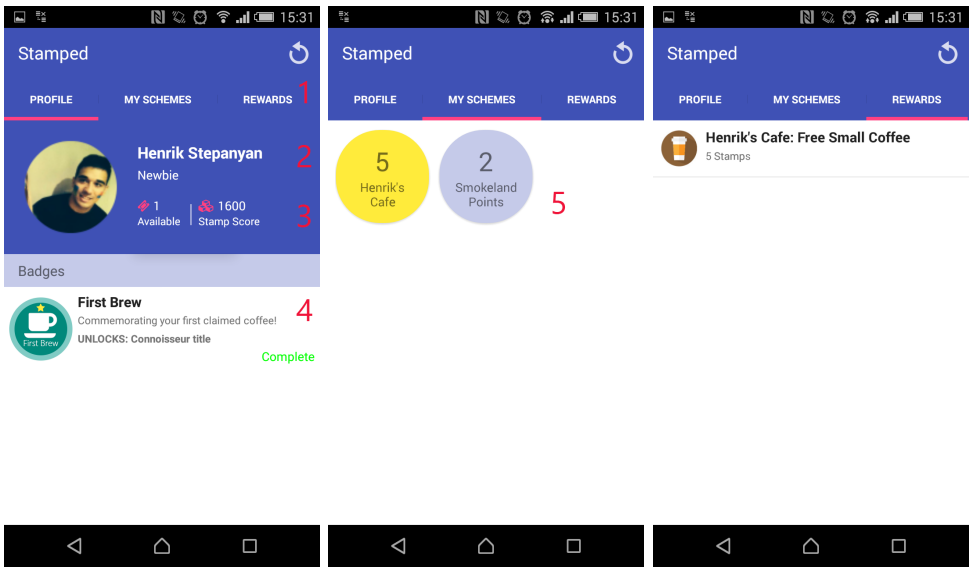

Figure 3.4: The final mockup of the Stampbook with a tabbed interface to be implemented

1. A tabbed interface allows switching between different functional areas of an app, therefore making them very useful if functionality can be categorised. Profile, My Schemes and Rewards were chosen as the functional categories. An action button exists visibly on the top right to sync a the users profile (loyalty schemes/rewards etc.) with the server.
2. The previous designs did not consider a user profile. The profile page aims to provide users a hub that presents them with their current account status. Customisability is

also possible here, for instance the ability to add a profile picture, or to choose from a range of personal titles.

3. Indicators are a key aspect of Nielsen's 'visibility of system state' heuristic [49]. A count of available rewards notifies how many claimable rewards the user has; whereas stamp score is a gamification currency which could be used to claim exclusive rewards in the future.
4. A user profile is a prime location to display achieved user badges. This will be discussed in section *(3.3.8 Incorporating Gamification/Persuassion)*
5. Solutions we explored in the literature survey implemented loyalty schemes as lists. As a result, the 'loyalty card' design from the previous iterations were transformed into bubbles within a grid. Businesses may be able to customize the background of the bubble with their own brand image. By pressing on the bubble, users are able to see the status of the scheme (Fig. 3.9). Referencing previous feedback, a golden tint represents a loyalty scheme which has sufficient stamps to claim a reward.
6. Further facilitating reward discovery, the dedicated rewards tab presents users with **all** available rewards they can afford with their stamps. This centralisation enforces a single convenient location to claim a reward.

Feedback For Next Iteration

- *"There should be more room for businesses to customise their schemes according to their brand"*
- *"Single rewards per loyalty scheme is great, but the design doesn't accommodate multiple rewards very well"*

Eventhough feedback for this iteration will not be implemented in the respects of time, it is important for future work.

3.3.6 Design Process - Loyalty Manager

Wire-Frame Mockups

A similar design process was adopted for the loyalty manager. Wire-frames were developed on paper using the Material Design guidelines (Fig. 3.5)

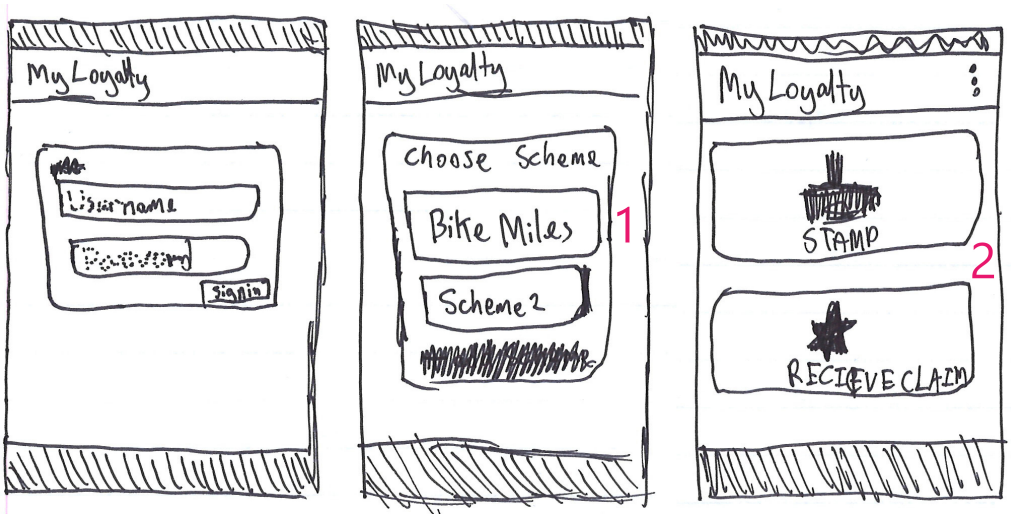

Figure 3.5: The initial wireframe mockup for the Manager using the Material Design guidelines

1. Users may manage more than loyalty scheme. As such, a menu is used in order to select the appropriate scheme.
2. The stamp page is designed to be very simple with only two large accessible buttons. Pressing on either should enable the NFC chip in order to distribute a stamp or claim a user reward.

Feedback For Next Iteration

- *"There should be a way to distribute multiple stamps"*
- *"A log of recent transactions would be useful"*
- *"The interface does not notify what loyalty scheme being stamped"*

As the functionality of this application is simpler than the Stampbook, feedback was easier to collect for the wire-frames. Suggestions, along with design patterns from the Stampbook were incorporated into the next iteration.

Iteration 2 - Final Design

A final design was developed by combining the aesthetic of the final Loyalty Stampbook prototype, with the suggestions from the previous wireframe (Fig. 3.5).

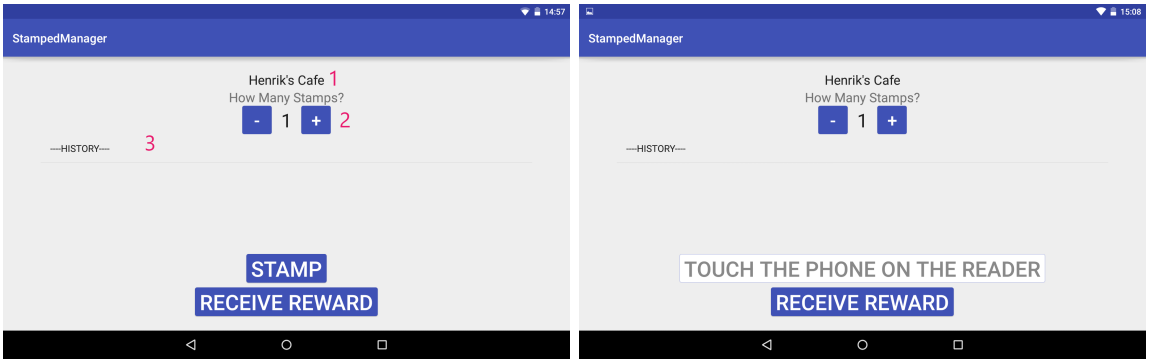

Figure 3.6: The final mockup of the Manager with the final aesthetic to be implemented

1. A notifier of the current loyalty scheme, as suggested from previous feedback.
2. A counter for the amount of stamps to distribute per tap. To facilitate ease of use, the number of stamps should reset back to one after every interaction. This will prevent any accidental 'overstamping' previous customers if the business employee forgets to reset the value.
3. The history provides a method of feedback to the employee. Upon all interactions, it should inform progress, successes and other key information regarding the loyalty schemes; however certain granularity had to be chosen.

Feedback For Next Iteration

- *"The buttons could be bigger like the original design"*
- *"There should exist an option to go back to the select a scheme page"*
- *"Transaction history need a way to be backed up"*

Due to limitations of time, this feedback will not be implemented into the system; however as with the Stampbook, they will be integral to future work.

3.3.7 Design Process - Database Design

Entity-Relationship Diagram

In section 3.3.2 we identified the need for a database. The design process was somewhat different than the applications as there was no user interface aspect involved. Initially, entities were identified for the schema - they were then normalised and translated into an Entity-Relationship Diagram (ERD)(Fig. 3.7) [51].

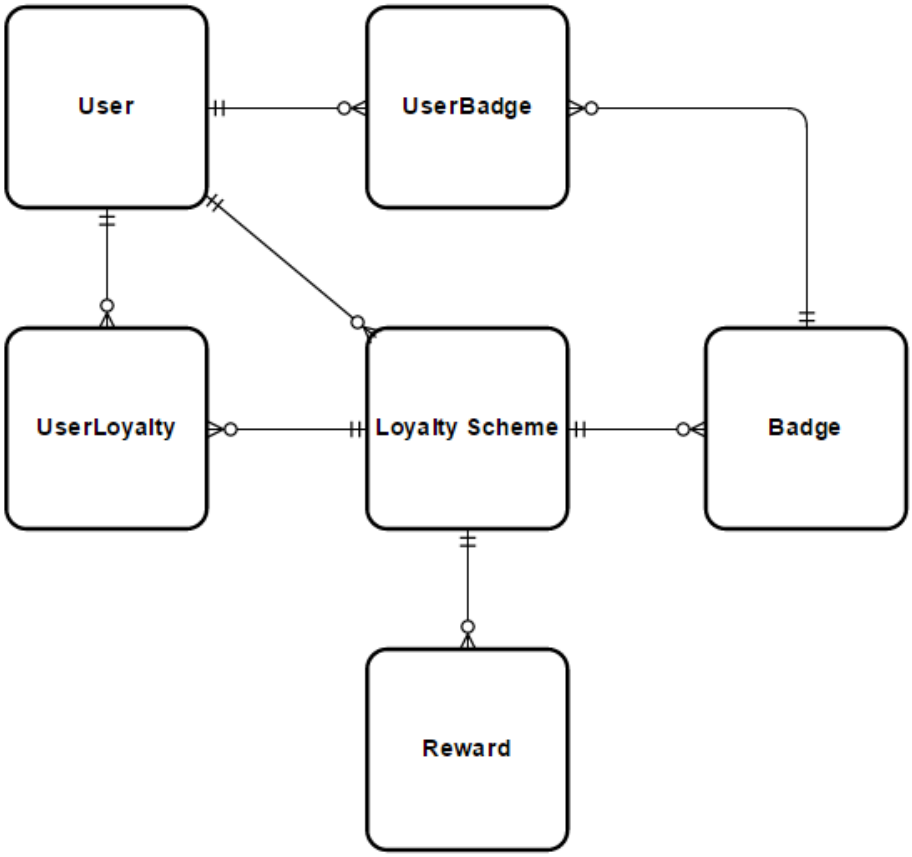

Figure 3.7: High-level Entity Relationship Diagram showing connections between different tables

The following features were identified to be reflected as table attributes:

- *facilitation of the gamification platform*
- *facilitation of scheme tracking/business intelligence*

Final Database Schema

Building upon the initial ERD and incorporating the above features identified into the schema, a final database schema is proposed (Fig. 3.8).

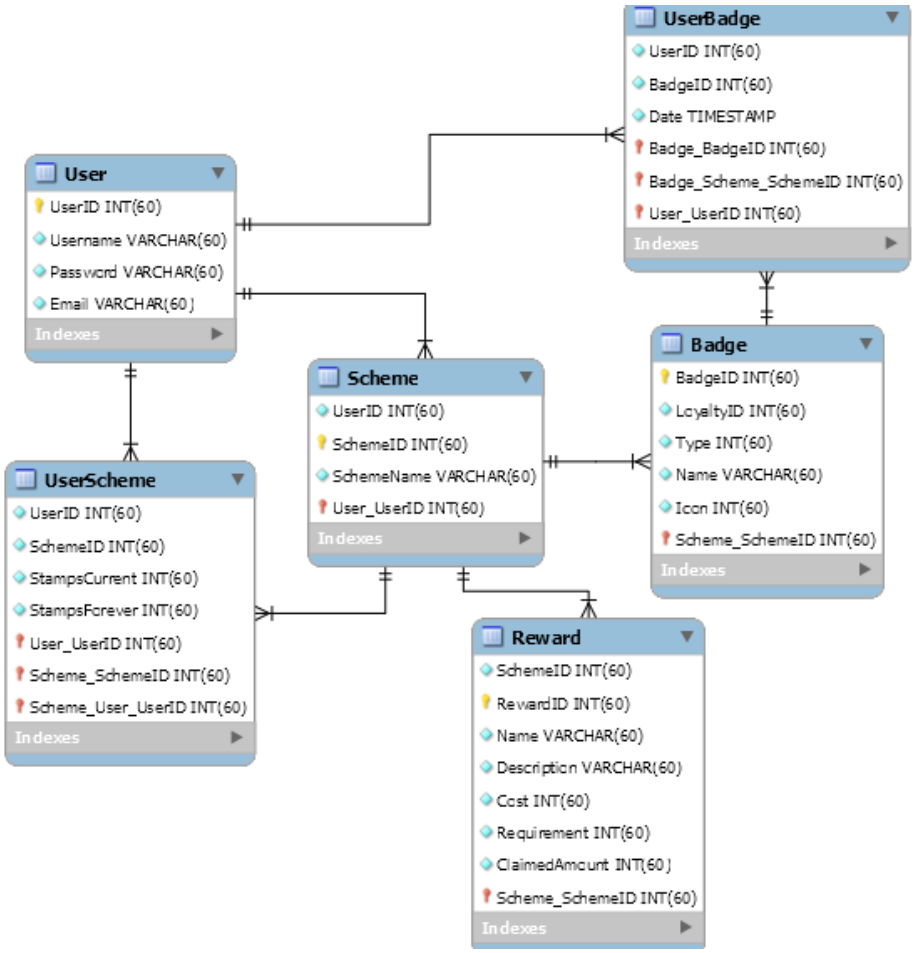

Figure 3.8: Final database model to be implemented

Analysis of Final Schema

In order to facilitate the gamification platform, we ensure that badges are independent from the loyalty schemes, affording the possible creation of unique badges by businesses. Moreover, the *stampsForever* attribute of UserScheme can be used to monitor how often a user visits a business. Leaderboards as gamification are also possible from this field.

ClaimedAmount from the Reward table, along with the aforementioned *stampsForever* attribute can be used by businesses to track the popularity of their schemes. This allows them to monitor changes and adapt their schemes accordingly.

3.3.8 Incorporating Gamification/Persuassion

Extrinsic Motivation

We previously defined the concept of 'extrinsic motivation' as incentives where motives to enact the task are not related necessarily to that specific behaviour. These are commonly seen in loyalty cards - for instance users may not necessarily want to drink a coffee but want to complete their stamp card. Several solutions we explored in the literature review implemented digital stampcard-like solutions.

Similar to the systems we reviewed in chapter 2, a virtual stampcard metaphor was integrated into our design (Fig. 3.9) as we felt it was familiar to users.

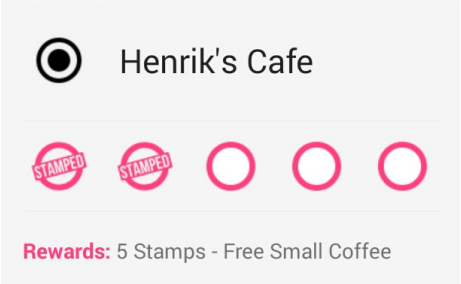

Figure 3.9: The loyalty scheme view displaying: reward, current stamps and the amount of stamps left in order to gather the reward

Badges

Badges were identified earlier as a type of gamification tool. They were not only one of the more popular tools, but also the simplest to implement. As with real-life, badges are awarded upon achieving certain goals. As such, we introduce simple achievements into our system. Moreover, we require an incentive to collect badges – therefore a title-system was added, allowing users to unlock certain and wear matching titles along with the achievement.

(Fig. 3.10) Shows how we integrated these principles into our design. The profile page makes an ideal home for collected badges.

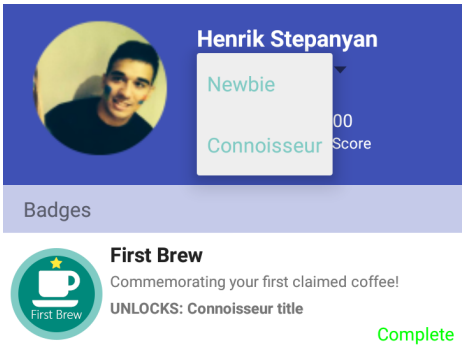

Figure 3.10: The badge view in the profile showing both the achievement and accompanied title earned by the user.

3.3.9 Naming The Systems

In order to give the system a brand identity, it was named 'Stamped' as it emphasises the software's focus on stamping. The 'Loyalty Stampbook' is to be called *Stamped*, whereas the 'Loyalty Manager' is to be referred to as the *Stamped Manager*. We hope that with a brand identity, users will be able to empathise and recognise the system better.

3.3.10 Conclusion

In this chapter we covered the requirements and design specification for our system 'Stamped'. Some of the design challenges were outlined, along with the different iterations that eventually lead to the final designs. The next chapter will cover the issue of implementation.

Chapter 4

Implementation

4.1 Introduction

In this chapter, we will present the different software components that were combined together to build our system. Problems with engineering and platform complexity will be highlighted, along with the process for solving them. The Android operating system brings many challenges with regards to development; however the goal is to explain those which are interesting when developing solutions relating to NFC. A basic knowledge of the Android platform will prove useful to fully understand this chapter.

4.2 Primary Technology

As explained earlier (blah blah reference), Stamped is to be developed on a popular mobile platform that supports the NFC standard, in this case Android. At this moment in time, developing a functional prototype for this system cannot be possible on another platform due to hardware and API limitations regarding NFC and Host Card Emulation. Expanding the solution to external platforms in the future will be difficult as it requires a rewrite with platform-specific code.

4.2.1 Software

Google provides a plethora of development tools in order to develop applications, one such tool is the development environment *Android Studio*. This kit provides an Integrated Development Environment (IDE) in order to design, configure and program the system. Android programs are coded using `JAVA` – therefore requiring an object oriented methodology.

Different Android devices run different versions of the operating system. Corresponding to each operating system version, there exists an accompanying Application Program Interface (API) that introduces new features to the ecosystem. We want our application to have the highest compatibility, but still contain the required features in order to satisfy the requirements. *Android 4.4 KitKat* is selected as this is when Host Card Emulation was initially introduced into the platform; however, this means that approximately 45% [52] of Android users have an appropriate version of operating system to run Stamped.

4.2.2 Hardware

Complementing the above choice of software, we require accommodating Android devices for development. Two devices were selected, a smartphone and a tablet. The tablet will be used to implement the Stamped Manager application as businesses will ideally mount Tablets onto a table next to employees to use. On the other hand, the phone will be used for the Stamped application as this is the common device customers will be using the system with. Both devices run the latest *Android 5.0 Lollipop* operating system - therefore supporting Host Card Emulation.

4.3 Other Notable Resources

4.3.1 Webserver with Database

To facilitate the backend of the system, we introduced a webserver/database backend in the design. A private webserver was purchased in order to facilitate the interactions with the database. The design database schema (Ref. SCHEMA) was imported into *PHPMyAdmin* and PHP files were developed to interface between the Applications and Webserver (The rationale for this can be found in (Sec. 4.4.3))

4.3.2 Android Debug Bridge (ADB)

Google provides a useful software for application testing called The Android Debug Bridge. This software interfaces with connected devices, providing the following features.

- The ability to see the console of the Android device in real-time whilst running the software
- The ability to control in-ward and out-bound network connections
- Error identification and debug output

ADB persists whenever there is a connection between Android Studio and a device, outputting feedback on its current state.

4.4 Implementation Complications

In this section a discussion follows the key implementation complexities whilst developing the system. Care was taken to abstract the problems of developing on the Android platform away from the issues.

4.4.1 Host Card Emulation

We earlier defined a need for an interaction architecture, identifying the Stamped application to interact using HCE as a smartcard. In order to do achieve this, a service will need to be created

Creating The Service

In order to provide functionality outside of an application, a 'service' must be implemented. A service is simply a component of an application which constantly runs in the background – Host Card Emulation is one such example of a component. In this case, the HCE service passively runs in the phone working memory, waiting to be triggered by an NFC Reader before sending a message. The purpose of having HCE in this form allows users to tap a reader to collect stamps **regardless of whether the application is open on the device or not**.

Android services must be carefully developed, as reckless design will lead to unwanted battery drain on the device. Fortunately Google provides a template class called *HostApduService* for HCE, ensuring that the service is optimised for power consumption.

Distinguishing Actions

A standard smartcard cannot tell what exactly is being read from it or when, a similar problem presents itself in the Host Card Service. The HCE service cannot atomically discriminate what message it needs to send, it can only react to an `onRead` event. To remediate this, we had to temporarily break the object oriented principle of encapsulation by introducing a shared global variable `NFCMessageType`. The message will allow the Manager application to discriminate what type of action we are broadcasting as a smartcard. Two such messages are adopted:

1. Stamp mode - Broadcasts the user account id
2. Reward mode - Broadcasts the user account id, the scheme id and the number of stamps to deduct in order to claim that reward

Passively the device is on 'Stamp' mode; however once a user selects a reward, they are presented with a popup (Fig. 3.9) to tap the reader in order to claim their reward. During this time, the HCE service will be in 'Reward' mode. As the popup is dismissed (from tapping the reader or having the user press cancel), we return back to Stamp mode. This technique underlies the systems ability to Understand Actions (Sec. 4.4.2).

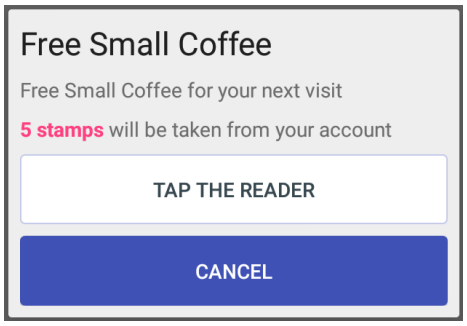

Figure 4.1: The popup presented to the user when they are about to claim a reward

Reacting to OnRead

The `onRead` function is usually strictly used to send a message to a reader. However, the event affords many opportunities for us to implement user feedback mentioned in the design chapter. For instance, we announce to the user whenever they have tapped their device using audio feedback and a notification (Fig. 4.2). This novel solution binds the interaction feedback to the service; therefore these functions can run in the background.

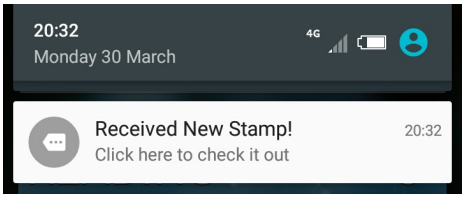

Figure 4.2: A Notification providing feedback to the user upon receiving a stamp

4.4.2 NFC Communications

Several presentation methods need to be put in place to facilitate NFC communication for our system. The messages being sent are simply hexadecimal plaintext; therefore there needs to be a way to send them in the correct format and carry some meaning to them. Here we demonstrate the principles to enable the Stamped Manager to understand messages.

Understanding Actions

The Stamped Manager must be able to distinguish the types of messages it receives. There are two kinds that it may encounter: A stamp request and a reward claim. We earlier explained two modes on the host card that send differing amounts of information. Likewise, the Manager was setup in order to analyse message content. If only the accountID was received, we know that Stamped Manager needs to provide a stamp, however when is presented with more information, the system recognises that a customer is claiming a reward and deducts the amount of stamps from their account.

Avoiding the 'Beam'

Android Beam is a feature of the Android platform to allow peer-peer data exchange over NFC [53]. Though it may have its uses (i.e Sending contacts, pictures), it can cause many problems for our system. Primarily, when two devices 'tap', the operating system may mistake it for a 'Beam' instead of a smartcard. This feature can be seen in (Fig. 4.3); however we draw attention to the message which says 'Touch to beam'. When this message appears, any input to the device other than that specific action is blocked. This will

naturally clash with the Stamped Manager, which is expecting a host card message instead of a 'Beam'

To solve this problem, we had to implement tight controls over how the Manager enables and disables its NFC chip, only enabling the chip whilst the reader is listening for a message from a host card.

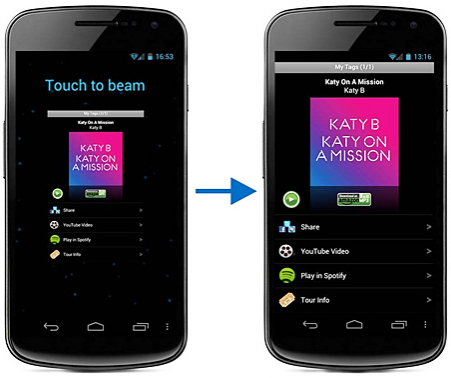

Figure 4.3: A demonstration of Android beam

ApplicationID Filtering

An Android device can emulate many smartcards simultaneously; however this is an issue for a NFC Reader as it will not be able to distinguish between the smartcards. We solve this issue through ApplicationID (AID) Filtering. Whenever a host card is setup, an ApplicationID must be assigned to it in the form of a hexadecimal string. An NFC Reader application can apply an AID filter with a matching hexadecimal string (Fig. 4.4) in order to identify and accept only the intended smartcard.

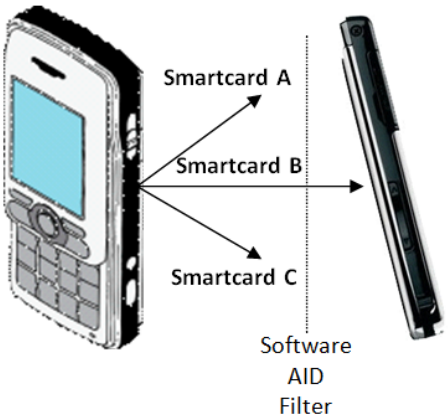

Figure 4.4: A schematic demonstrating software AID Filtering

4.4.3 Database Communication

A large part of the system interactions involve reporting back to the central database in order to sync 'stampbooks' along with user profiles. We deduced during the design stage that only the Stamped Manager will have access to modify entries in the database, whereas the user Stamped application will only be able to read from it – A discussion follows on the implementation of database communication for our system.

PHP Interface

Interfacing directly with SQL is highly difficult and insecure in the Android platform. To solve this a new interface had to be made using PHP. In this architecture, applications send `GET` and `PUT` requests to the server, identifying actions by using 'tags'. PHP in turn works as an intermediary, sending input to the database and providing output back to the Android application. Unfortunately this means that functions have to be written essentially twice, as they need to be written in JAVA to call a PHP, along with being written PHP to handle the input/output.

Database Requests

Requests to the database take time, and therefore must be threaded properly on mobile platforms. Android is very strict with regards requests what is allowed to run on the UI Thread. Requests that are recognised to be time consuming (i.e. Database requests) must be setup to run on a separate thread of execution. The adverse side effect of this requirement introduced the problem of race conditions in our UI.

Dealing With Race Conditions in the UI

Consider the following example – A user is syncing their 'stampbook' to see how many stamps they have for each of their loyalty schemes. The request runs in a background thread; however it does not update the new stamp values as they have already been drawn on screen. We fix this by constantly updating the views every few seconds. This solution was not ideal, nonetheless it did remediate our race conditions.

4.4.4 Internal Database Management

Storing information on Android can be non-intuitive. Basic credentials can be cached through plain text files; but in order to store the complex inter-relating data of our system. An internal database needs to be deployed to serve as local storage. Here we outline the novel challenges when working with both an internal and online database.

The Internal Database

Information gathered from querying the online database has to be stored somewhere, as a result, a `SQLite` database is setup with an identical schema. The idea is to have a clone of the parts relevant to the user (i.e. Account details, loyalty schemes, available rewards) of the online database stored locally. This vastly reduces the number of database calls that need to be made, as well as solving our information storage problem. On the other hand, it adds an extra layer of complexity as some SQL queries will still need to be run on the internal database **as well as** the online database.

4.5 Delivery of Requirements

Here we will compare how well the implemented system delivered on our earlier requirements.

4.5.1 Overview

Here we show a high-level overview of how many MoSoCoW requirements were completed.

- Must Have – 7/7
- Should Have – 3/6
- Could Have – 5/7
- Wont Have – 0/2

4.5.2 Requirement Fulfillment

M1 **Sign-In & Registration**
Users are able to sign-in to the system with their accounts

M2 **Fast Stamping**
Stamping in the adopted design is pervassive; therefore no buttons on the user interface is needed. Any tap on a listening reader will provide a stamp.

M3 **NFC Transmission**
Host Card Emulation is used to send messages over NFC.

M4 **Online Syncing**
The system actively syncs the status of user 'stampbooks' with the online database.

M5 **Sync on Interaction**
The `onRead` event triggers a sync with the database whenever an interaction between two devices take place

M6 **Syncing Time**
A fast backend and grouped data in the `JSON` format affords fast syncing.

M7 **Feedback on Interaction** *The system provides an audible sound and a notification whenever an interaction occurs.*

S1 **Consistency**
The system user interface was implemented using Google's Material Design.

S2 **Rewards Browsing**
There is a dedicated rewards tab to allow users to browse all available rewards for a loyalty scheme.

S3 **Badges**
Users are able to collect standard badges which earn a user 'title'.

C1 **Passive Card Emulation**
The system does use passive host card emulation.

C2 **Branding**
Some customisation options are available to schemes; however no frontend for them was implemented

C3 **Internet-Free Stamping**
Only Stamped Manager requires an internet connection in order to provide a stamp. Customers can sync their stampbook whenever they have an internet connection to update their local stampbook.

C4 **Multiple Device Support**
Having an online database affords the use of using your account on multiple devices - moreover they will be synced with eachother

C5 **User Personalisation**
Our system allows the personalisation of profile pictures and user-earned 'titles'.

4.6 Design Conformance

By following the criteria laid out in the design chapter, we managed to successfully produce two android applications which allow users to do the following:

1. Collect stamps for corporate loyalty schemes
2. Track progress of all loyalty schemes in real-time
3. Expend stamps in order to claim rewards
4. Collect badges to improve customer engagement

4.7 Conclusion

Throughout this chapter, we have concentrated on implementing a system in order to meet our requirements and design specifications. In the next chapter, we will introduce and perform a user field study to assess the system in a naturalistic environment.

Chapter 5

Evaluation

5.1 Introduction

This chapter outlines the process for evaluating the system, describing a field study in a naturalistic environment

5.2 Field Study - Observation of The System In a Natural Environment

5.2.1 Outline & Objectives

The primary purpose We aimed to identify the contribution of gamification on the system: whether it improves or hinders user engagement & enjoyment. To quantify the value of gamification to the system, we use an A/B Testing [**?**] approach. This involves comparing two near-identical versions of the system with the exception of a single variation, allowing us to measure the impact of the variation on user behaviour. As such two systems were implemented **'System A' (without gamification)** and **'System B' (with gamification)**.

5.2.2 Study Methodology

There exist two applicable methods to evaluate our system, laboratory and field studies. We can define a laboratory study as:

> 'A research study conducted in a contrived setting in which the effect of all, or nearly all, influential but irrelevant independent variables is kept to a minimum." [54, p. 215]

Lab experiments are preferable in situations where the environment and variables need to be controlled in. The outcome of this method is specific data to what you want to test. On the other hand, the controlled surroundings may ignore not reflect the use of the system in a wider context.

Oppositely, a field study is:

> "A research study conducted in a natural setting in which one or more independent variables are manipulated by the experimenter under conditions controlled as carefully as the situation will permit."[54, p. 211]

The advantage of a field study is the ability to test the system in a natural environment, allowing us to deal with the exact same environment where the system would be used. On the other hand, we have less control of the external variables, which may introduce 'confounding variables'[1] that can negative affect the studies external validity [55].

[1]Confounding variables directly or indirectly link the dependant and independent variables.

Selected method

A field study was selected as we want to see how our novel way of collecting loyalty stamps works in the real world. Not having control of the environment can prove advantageous as we can isolate and remediate any negative variables that can be caused by 'natural use'. A pilot study (to be discussed in Sec. xx) will need to be performed in order to identify some of these variables.

5.2.3 Demographics

Six participants were recruited that owned a compatible Android device (Android 4.4 KitKat+) for our system. An even amount of male and females were recruited eventhough women tend to frequent loyalty schemes more often than men[56]. All participants were students within our target demographic of 16-40, having the average age of 21.5.

5.2.4 Preparation

Two systems were prepared for the study — 'System A' (without gamification) and 'System B' (with gamification). The primary functionality of both systems are identical except for the addition of badges/quests to System B. Participants were evenly assigned a system to test at random. We required users to install the application on their own device to ensure the system works with a variety of hardware.

An example loyalty scheme 'Bath Cafe' was setup for the Study (Fig. 5.1). It was designed in such a way that users will be able to claim at a free coffee by the end of the study.

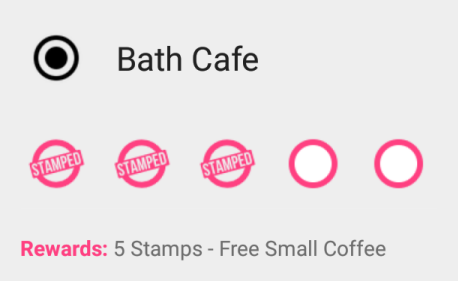

Figure 5.1: The example loyalty scheme to be used in the study. A reward of a free coffee is offered upon completing the stamp card.

An accompanying badge was created for the loyalty scheme, as can be seen in Fig. 5.2. The badge was purposefully simple to collect in order to be attainable during the study.

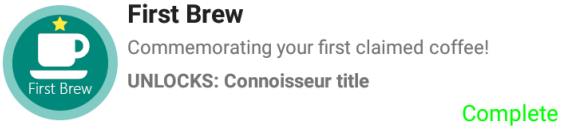

Figure 5.2: A badge implemented for the study. Both the badge and the 'connoisseur' title unlock when a user claims their first coffee.

Three coffee shop locations were identified on the university campus to perform the field study. A random location was to be visited on each of the five days. At each location a business employee will be asked to use the 'Stamped Manager' application to facilitate our study.

5.2.5 Developing The Questionnaire

The primary method of gathering quantitative data from this study is using a questionnaire, complimented by some comment questions to gather further qualitative data for their answers.

We prepared two questionnaires, one for the participants to complete upon finishing the study and one for a coffee shop employee to fill-out at every unique location visited for the study. An explanation of their purpose follows:

Questionnaire For Users

The user questionnaire attempts to quantify the participant's loyalty scheme patterns and their response to the application and technology. To achieve this, the questionnaire was broken down into several sections.

- *Questions 2 & 3* quantifies a participants behaviour regarding loyalty schemes. Having a wide variety of loyalty scheme behaviours allow us to get a complete range of opinions regarding our system.
- *Question 4* was introduced from the Technology Acceptance Model (TAM) [57] (Fig. 5.3). The TAM models how individuals accept and use new technology based on 'perceived usefulness' and 'perceived ease of use' factors— satisfying these variables predicts a system that is more likely to see use [57].
- *Question 5* one way in which we can gauge how much participants enjoyed using the system is to identify whether the participant would recommend the system to friends. Furthermore, personal use also indicates system enjoyment.
- *Questions 6 & 7* Are specific to the tested system, only one of them requiring an answer. By asking these questions, we aim to understand what potential impact, positive or negative, gamification can have on the system.

- *Question 8* Requires users to provide qualitative feedback about their experience. We ask for positives and negatives in order to encourage a balance in the answers, along with suggestions for system improvements.

Whereas question 4 is designed to measure user trust in the system (whether users will use the system), questions 5, 6 and 7 are to be used to measure our hypothesis.

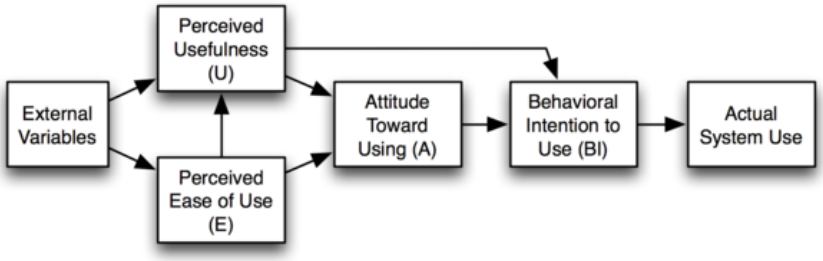

Figure 5.3: The Technology Acceptance Model (TAM)

Questionnaire For Business

The business questionnaire is designed to give context to the location where a field study is being performed. The questions mainly identify what type of loyalty schemes exist within that business, the rewards they give and the percentage of customers that participate in them. Finally there is an option for employees to provide feedback on the Stamped Manager. Effort was made to keep this questionnaire as simplistic as possible to ensure minimum disturbance of the employees.

5.2.6 Pilot Study

A pilot study allows the identification of correct processes and captures any small issues that may affect the primary field study. The primary purpose of the pilot is to assess the interaction using the application on a participant's phone.

A separate participant was recruited. She described limited-to-no knowledge of mobile technologies and was a casual consumer of smartphones. They were told to download and install Stamped, whilst we installed the Stamped Manager on a tablet device. A list of tasks was generated in order to test the 'interaction elements' (stamping/reward claiming) of the applications. In the interest of time, we designed the tasks to be completed in one sitting.

The list of tasks were as follows:

1. Login to the system using your university email and password '1234'
2. Ensure your phone is unlocked (you do not need to have the application open) to

collect a stamp

3. Tap your phone onto the reader when asked (you will be given 5 stamps)
4. Click on the notification/open the application
5. Ensure you received 5 stamps in the loyalty scheme 'Bath Cafe'
6. Swipe to the profile page
7. Confirm that you have 1 available reward on your profile page
8. Swipe to the rewards tab
9. Select the available reward 'free coffee'
10. Notify the researcher that you want to claim a reward
11. Tap your phone onto the reader when asked
12. Open swipe to your schemes and ensure the stamps have been deducted

Findings The user was proficient at navigating the application, a tabbed interface proved to be easy for them to understand. Several user interface bugs were also quickly discovered, such as no feedback when a user tries to login with incorrect credentials. These were corrected before the main study took place.

Some questions on the questionnaire were deemed to be be confusing and had to be revised for the future study.

Various hardware-level issues were identified that intruded with the interaction. Different phones have their NFC Chip located in various places, making it difficult to know where users should tap their device. There were points where they were sliding the back of their phone on the tablet in attempt to trigger the interaction. Moreover, we identified that using a very thick protective 'phone-case' (as the participant had), limited some NFC signal.

Positioning the tablet on the stand was a problem. The stand put the device at an awkward angle on table with regards to the user, making it difficult to tap the back of the device with a smartphone. Furthermore the awkward angle sometimes caused a 'weak NFC interaction'[2], providing unintended feedback that would trick users into thinking that an interaction has occurred.

Solutions As a majority of the issues were hardware orientated, several process solutions were implemented to remediate them for the main study. Firstly for future participants, we checked if their phone-case was not too thick, asking them to remove it for the purpose of the study if necessary. Secondly they were instructed to 'swipe' along the back of the tablet instead of a simple tap to ensure the NFC interaction completes.

[2]A weak NFC interaction occurs when an NFC interaction is interrupted mid-way, thus one device fails to communicate its message

The ideal solution for this problem would be to purchase a USB-to-MicroUSB adapter and a standalone USB NFC reader for the Stamped Manager (Fig. 5.4), having the user tap their smartphone on the reader instead. Using this configuration will not only correct the awkward angle/weak interaction problem, but will also provide NFC functionality to devices that do not have it available.

Figure 5.4: A smartphone device connected to a USB NFC reader

5.2.7 Hypothesis

We clarify our hypothesis to be expanded on as **Hypothesis A: Participants using Gamification are more likely to enjoy to system and recommend it to friends**. We understand that 'enjoy' is a very general term, and therefore attempt to quantify this by using questions 5, 6, 7 in our questionnaire as our dependant variables (Fig. 5.5). Those with gamification should respond more positively to question 5 than those without. Moreover, participants should respond positively to the question unique to their system.

5. Please rate the following

	Extremely Likely	Very Likely	Somewhat Likely	Unlikely	Very Unlikely
how likely would you use this system on a regular basis	○	○	○	○	○
how likely are you to recommend this system to friends	○	○	○	○	○

6. [ONLY ANSWER THIS QUESTION IF YOU TESTED SYSTEM A]

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
badges/acheivments would encourage you to use the application	○	○	○	○	○

7. [ONLY ANSWER THIS QUESTION IF YOU'RE USING SYSTEM B]

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I enjoyed collecting/engaging with badges	○	○	○	○	○

Figure 5.5: Questions 5,6,7 of our questionnaire to be used as our dependant variables

5.2.8 Approach

Here we describe the process by which the study was performed. The researcher began by briefing the participants as per Fig. XXX on the context and purpose of the project. They were guaranteed that the system is being tested rather than themselves, along with the confidentiality in their responses by storing no personally identifying information. Participants were then required to download and install their assigned system onto their smartphones (Fig. 5.6) — instructions can be found in appendix XXX. Finally, they were asked to sign a permission slip, an example of which can be seen in Sec. XXX.

The main directive given to the participants is that they must collect stamps throughout the study, claiming a free coffee once they have accumulated enough of them. Those testing System B (with gamification) were directed to ensure that they collect the badge by the end of the study.

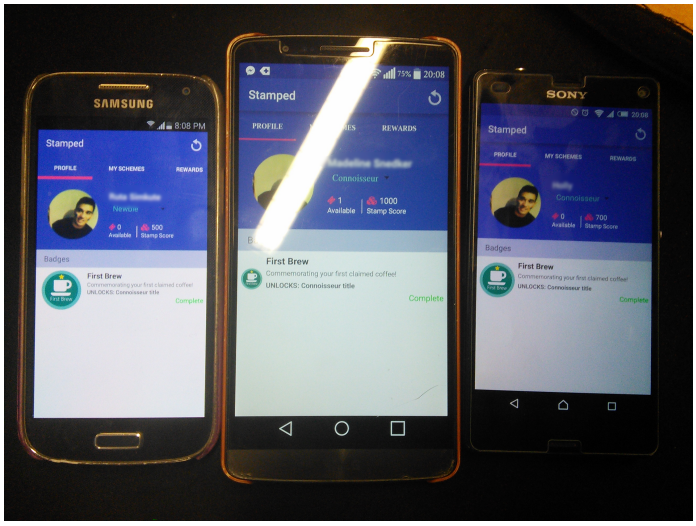

Figure 5.6: A photograph showing the three devices which used System B

We began the study by setting a convenient time to meet everyday in an earlier communicated coffee shop for the session. It was important to select a non-peak time as to minimise disturbance to the staff. All six participants were sat down and asked to wait; meanwhile the researcher asks the coffee shop employee to use the tablet with the Stamped Manager installed for the next six people that ask for a 'digital stamp'. They were assured that the stamps were only for a study and not legible — this was followed by a quick training on how to use the Stamped Manager. The tablet was left on the till, ready for the employee to use to distribute stamps.

Once training was completed, the participants were instructed to travel individually perform a regular coffee shop transaction, claiming a digital stamp (or free coffee) from the employee. The interaction was two-way; employees have to to press the appropriate button on the Manager (Stamp/Receive Reward), whilst the participants swipe their phone onto the back of the tablet (Fig. 5.7). Meanwhile, the researcher sat down to observe the interactions between them. At the end of each session, the researcher would ask the employee to fill in the business questionnaire. Once all formal parts of the session were complete, participants were offered a cupcake for their troubles.

Figure 5.7: An photograph of the field study - a participant is seen claiming a stamp at the counter of a coffee shop

This format was repeated every day for five consecutive days (Monday-Friday), with each session lasting 10-20 minutes. By the end of the study, participants should have tested all three main interactions (stamping, reward claiming and badge receiving). Finally, upon confirming that all participants have completed their tasks, the post-study questionnaire was disseminated for them to complete.

5.3 Conclusion

This chapter outlined how our field study was conducted, along with the elements which we are trying to quantify. In the next chapter, we will discuss the findings of the study.

Chapter 6

Results & Discussion

6.1 Introduction

6.2 Conclusion

Chapter 7

Conclusions & Future Work

7.1 Conclusions

7.2 Future Work

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Appendix A

Interview Transcript

Tell me quickly about your role

I am a Business Analyst for the WREF (Worldwide Real Estate and Facilities) IT. My role within IT is facilitating any technological solutions required or requested by the WREF team; on or off-site.

What are Bike Miles within COMPANY A

Bike Miles within COMPANY A is a loyalty scheme for permanent COMPANY A staff members at 3 UK sites. Under the scheme, users who enter those sites are entitled to a sticker, which equates to £1 that can be spent in the bike shop (Evans Cycles). From the 3 sites that have the Bike Miles scheme, there are approximately 7000 staff members with 2100 users registered to the scheme of this, 800 active users (active users are those who have claimed more than £50 within the last year).This scheme is used to encourage our staff to get fit by riding to work, save the environment and help reduce the need for parking with the very limited spaces available at sites.

What's the current scenario now

The current scenario consists of the following:

1. Users come to the security barrier on site
2. They tear off a sticker
3. They then use their COMPANY A pass which opens the barrier, enabling them to enter the site
4. The sticker is put into a collecting paper card
5. The paper collection card is presented to the bike shop for money off

What problems are there to tackle?

With the existing there are a lot of problems to tackle as we believe people are abusing the system.

- Anyone can enter the scheme – Therefore we cannot track who is actually regularly riding their bikes onto sites. In regards to the 800 users listed above, they could potentially come into site in a car and still take a sticker.
- People are taking more than one sticker at a time, with no security preventing the problem
- Contractors are not entitled to the scheme, but could still take the stamps.
- We believe there is a 'black market' for the stamps whereby users are taking the stamps and passing/selling them on to other staff members.

What solutions have you guys thought about

We have looked at other ideas to try and overcome the problem, but under current COMPANY A policy no new applications can be submitted into the current pool of apps. With that in mind a solution was required whereby staff could use their existing COMPANY A

card to enter site and store Bike Money, or something similar with a smartphone:

- COMPANY As corporate device is the iPhone, an application with a QR code scanner which increments on a daily basis upon entering site
- NFC solution with sticker on the back of existing staff card – Or with the new iPhone 6 this is already incorporated.
- Fingerprint scanner (but no new applications)

What do you think of this solution? (The corporate loyalty app)

For this solution to be feasible and useful, it would need to be:

- Available for all of our permanent staff to use
- Easy integration for further sites and users globally
- Good usability aspects. COMPANY A has 100,000 staff members with a variety of demographics, therefore all users should find it easy to use and better than the existing process
- The system would need to increment on a daily basis when the staff members enter site (once a day only)

The corporate loyalty scheme is a great idea. Not only could it combat the issue of Bike Miles, as listed above, but it could also be used in conjunction with a lot of the other internal schemes that we have on site, such as Coffee loyalty scheme, gym membership, COMPANY A product store discounts (including online) etc.

Could it be considered by COMPANY A?

COMPANY A are always looking to improve, therefore if a product is received that significantly improves an existing process / technology it may be considered. Mobile phone applications have become more popular in general in recent years and this has rubbed off on COMPANY A staff members to change their perception (who previously were against mobile technologies). Also off the back of our recent success in winning an award for the Best Use of Mobile Technology Award (COMPANY A SiteMap App) we believe that mobile products can enhance our reputation internally and externally.

Appendix B

Initial Wireframes

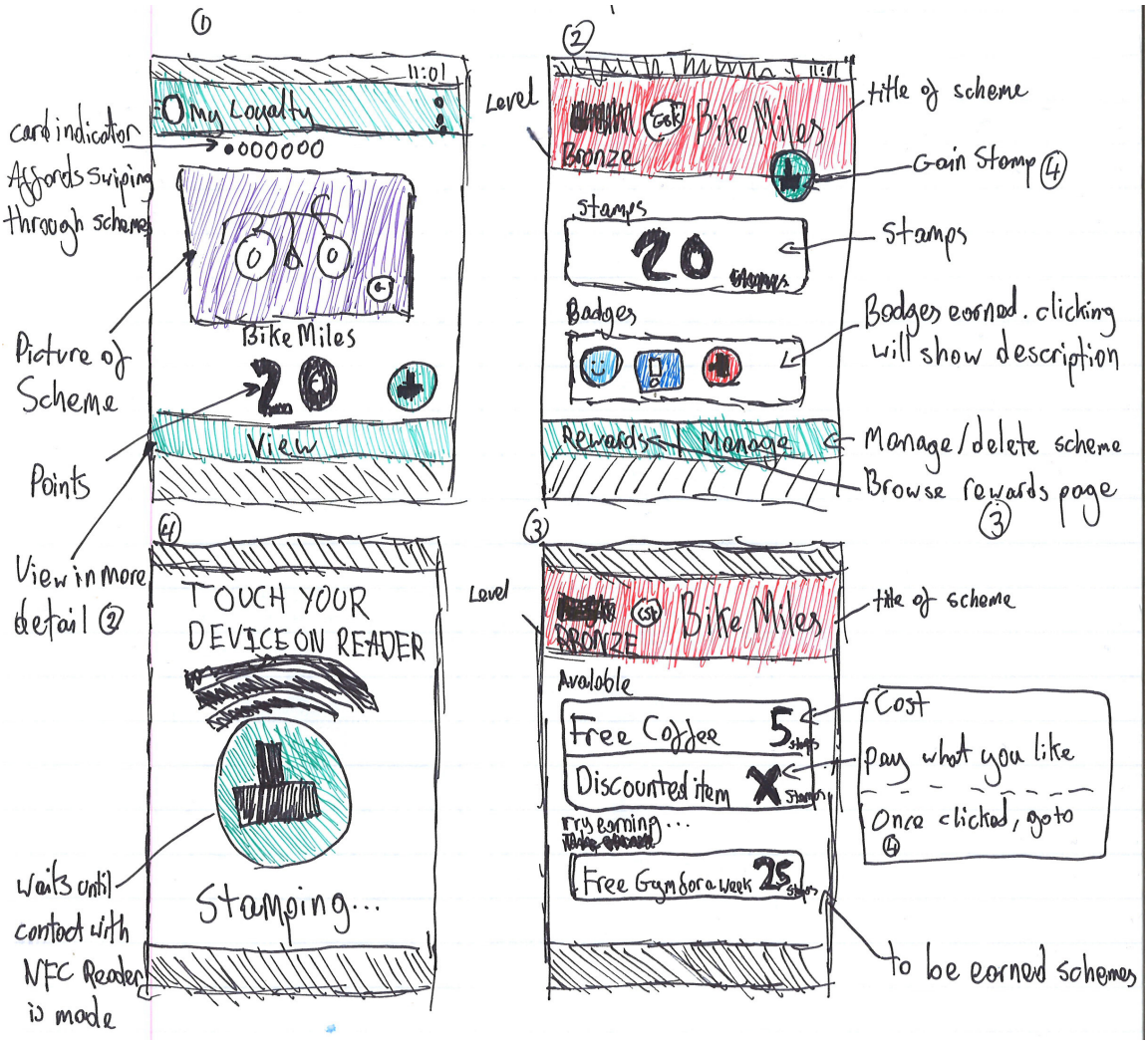

Figure B.1: The initial wireframes for the Stamped system

Appendix C

Permission Slip

Permission Slip

Mobile Technologies Supporting Corporate Loyalty Schemes

Accountability

All data will be treated confidentially and stored without identifying characteristics. You will be asked to consent to your data being used anonymously and are reminded that you may decline any task. You make also leave and take a break whenever one is required.

The researcher will give you a verbal briefing at the start of the study to summerise the above. Please feel free to ask questions at any point during the study, or contact either the researcher or project supervisor in the future.

Contact

	Researcher	**Supervisor**
Name	Henrik Stepanyan	Dr. Fabio Nemetz
Email Address	hs409@bath.ac.uk	f.nemetz@bath.ac.uk

If you are unable to contact either of the above, please direct queries through the Department of Computer Science, University of Bath

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Permission

please indicate that you have read and understood this briefing and that you agree to participate in the study, by signing here:

Signature: ..... Name: .....

Your identity will only be used to record that permission was granted, and is not tied with the data you provide.

Appendix D

Instructions For Study

Installation Instructions

1. Browse to [link]
2. Download the application
3. Go to Settings ¿ Security - Ensure that ‘Unknown sources’ are enabled
4. Install the downloaded application
5. login with your university email - the password is 1234

Stamping Instructions — Stamped

1. Ensure your phone is unlocked (you do not need to have the application open)
2. Swipe your phone onto the reader when asked
3. Click on the notification/open the application
4. Ensure you received a stamp

Claiming a Reward — Stamped

1. Open the application
2. Ensure you have 5 stamps in the loyalty scheme ‘Bath Cafe‘
3. Swipe to the rewards tab
4. Select the available reward ‘free coffee‘
5. Notify the employee that you want to claim a reward
6. Swipe your phone onto the reader when asked
7. Open the application and ensure your stamps have been deducted

Instructions — Stamped Manager

1. (for stamping) Use the '+' and '-' buttons in order to select the number of stamps to distribute
2. press appropriate button for stamping/reward claiming
3. ask customer to Swipe their phone onto the reader