

Designing a digital key for hotel applications

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ABSTRACT

Although hotels have already started to implement online check-ins and digital keys in their applications, there has not been much research on the design of these prominent features. This thesis focuses on designing a digital key that is both easy to use and perceived as safe. A Research through Design approach was followed consisting of semi-structured interviews, an analysis of textual user reviews, and Lo-Fi and Hi-Fi prototyping in order to understand the needs and problems users face while receiving and using a digital key, as well as to provide further design directions for this feature. The findings showed that using a mobile phone to open a door or gate was already part of some of the participants' daily life. Still, many people do not like to rush into this digitalization. Hotel guests do not seem very worried about safety and using a digital key because the level of trust is high in the hospitality industry. The design presented in this paper serves as a starting point on how to design the receiving and using of a digital key.

KEYWORDS

Hotel applications, digital key, perceived safety, check-in / check-out, user-journey

1 INTRODUCTION

The check-in process at hotels can be slow and frustrating. Long queues can be expected at the check-in counter, especially during holidays. Furthermore, guests need to bring several documents to make sure the check-in process can be completed. According to Pingitore et al. [18], for European guests, it takes only 10 minutes of waiting time at the check-in counter to lower their satisfaction by 50%. For Americans, this is 5 minutes and for Japanese guests, this is 30 minutes, the authors argue that this is due to cultural differences. Currently, hotels are using key cards with a magnetic strip, smart wristbands, or Radio-frequency identification (RFID) cards to open hotel rooms. Guests have to check-in at the counter to receive them. In order to try and improve this situation, hotels have started to create applications for their guests through which it is possible to interact with hotel services.

These hotel services are called "At Hotel Functions" and they are becoming increasingly important for hotels to engage with their guests [3]. Different examples of these functions are, check-in/check-out, room service, digital concierge, and a digital key. These "At Hotel Functions" are becoming

increasingly popular among hotel guests. A survey conducted by MCD in 2014 [11] states that 73% of travelers would like to be able to check-in or request a late check-out through their phone and 64% of travelers would like to use their phone as a room key. According to J.D. Power¹ [19], currently only 4% of hotel guests use mobile check-in, however, the check-in/check-out satisfaction is the highest among these guests. Consequently, hotels are now trying to implement several of these "At Hotel Functions" in their applications. However, there has not been much research on the design of these prominent features [6].

During a hotel stay, there are three different phases, pre-stay, in-stay, and post-stay. This thesis focuses on the features used during the in-stay phase, in particular, the digital key. The digital key is embedded in the hotel's application and uses either Near Field Communication (NFC), Bluetooth, or Bluetooth Low Energy (BLE) to open the door. This feature can create a more seamless experience for the hotel guests [9]. Seamlessness can be described as the level at which users transition from one activity to another in a way that is smooth, uninterrupted, and hassle-free. This term is used throughout this thesis and is defined as the level of ease at which users are able to go through the check-in process and into their room. By removing the physical check-in at the counter a higher level of seamlessness can be reached. To receive the digital key, hotel guests should check-in through the application. Once they are checked-in, they receive both their room number and the digital key. This process is beneficial for both the guests and the hotel, guests can go directly to their room instead of waiting at the check-in counter [18], and the hotel has a new platform to engage with the guests [6].

A study by Morosan et al. [13] found that general security concerns of hotel guests can influence how they feel about a new technology, which in this case was NFC mobile payments. Consequently, I would argue that the same can be true for digital keys. Therefore, one of the main directions for this research was to find out how to design a digital key that is perceived as safe while still being convenient to use. The term perceived safety is used in this thesis when talking about the feelings of the hotel guests when they close the door of their room during two different situations, leaving the room and arriving at the room. When they leave, they want to be sure that their items are safe inside the room and

¹J.D. Power provides consumer insights and has produced a hotel guest satisfaction study for the past 23 years.

when they arrive at the room they want to know for sure that others cannot suddenly come into their room. These two situations are important to keep in mind to make sure the digital key is perceived as safe. Security on the other hand is more focused on the protection of the hotel guests against external threats, such as thieves. Security is focused on the technologies used, while safety is focused on the internal feelings of the hotel guests.

This thesis was carried out at The Mobile Life, a mobile app development company. One of their clients wants to create a hotel application and is the main stakeholder of this work. The other stakeholders are the hotel guests, personnel, and thieves. While all of these stakeholders are important, I mainly focused on the hotel guests, because user satisfaction often goes hand in hand with the financial interest of the hotel. I focused on the design of the digital key as well as the user journey around receiving the digital key. A research through design approach was taken to find out how a digital key can be designed to serve the hotel guests and make them feel safe. Through interviews, analysis of textual user reviews, and discussions both Lo-Fi and Hi-Fi designs were created during this project.

2 BACKGROUND AND RELATED WORK

2.1 Current check-in process

Hotels have tried different approaches to create a more seamless check-in experience for their guests. Hotels started by introducing self-service kiosks (SSKs) which are used to check-in and receive a key without having to interact with any employees. The problem of these SSKs was that there are still long queues during holidays, and not all the guests are comfortable with using a technology they never used before. To solve this issue, some hotels added the option to check-in online. This can be done at home on a personal computer or mobile phone that guests are already familiar with. The guests receive their room number and a 'digital key' in the form of a Quick Response (QR) code. This QR code needs to be printed or stored on the phone and can then be used to receive the key at an SSK or to open the door of their hotel room directly. Finally, due to the latest developments in the smartphone sector, many hotels try to improve the check-in process by creating an application through which hotel guests can check-in and receive a digital key with their room number. The digital key is then used to open the door. This can be done with different technologies, often either NFC, Bluetooth, or BLE is used. The different approaches and technologies presented in this background are discussed in more detail in the following sections.

2.2 Hotel applications and feature classification

Both Gibbs et al. [7] and Neuhofer et al. [15] segment the different features of hotel applications by their technology

intensity. They state that features that are more technology-intensive result in a more personalized experience for the guests and increase user satisfaction. The feature categories in this technology-intensive level are personal concierge services, property-specific technology tools, and context-aware navigation. Hotels need to implement these features for every stage, pre-stay, in-stay, and post-stay. This means letting customers search and book their room, check-in, navigate to the hotel, use a mobile key, request amenities, check-out, and provide feedback in the app after the stay. Hotels that successfully implement these features in every phase can improve user satisfaction and keep guests from using online travel agencies instead [7]. As mentioned before, in this research I focused on the features that are used during the in-stay phase, which includes property specific technologies such as mobile check-in and the digital key. It is, however, important to keep in mind the whole user journey when designing these features.

Adukaite et al. [1] state that the focus of current applications in the hospitality sector is on showing informational and functional content, as well as on booking rooms. They mention that although this is what the hotels currently offer, they also found that hotels want to create features that make it possible to interact directly with the customers. Chen et al. [3] describe the different features and functions of smartphone applications for hotel chains. They divided the features into five different sections: Reservation Information, Hotel Information, At Hotel Functions, Social Media Links, and Additional Features. This study is followed up by their next paper [4] in which they performed an importance-performance analysis of smartphone applications for hotel chains. Chen et al. argue that *"Hoteliers should move beyond providing 'Reservation Information' and 'Hotel Information', and develop more 'At Hotel Functions'"* [4]. These 'At Hotel Functions' include Check-in/out, Concierge Tips, and Digital keys, which is similar to the technology-intensive features mentioned before. In their research, the customers gave high ratings to these "At Hotel Functions" and perceived these as important, even though most applications did not have them yet. Their research, however, does not attempt to explain why certain functions are more important than others.

Digital keys in the hospitality sector

Different studies focus on the development and usage of digital keys in the hospitality sector [5][9]. The authors of these two studies managed to create a system that lets hotel guests check-in and unlocks their door by using a QR code sent to the guests beforehand. Their studies showed that the system is perceived as secure, useful, and easy to use. Furthermore, the users accepted the new system without problems regardless of gender, age, and user familiarity with technology.

The authors of both studies argued that QR codes would be more appropriate to use compared to an application that uses either BLE or NFC to open the door as not all of the hotel guests would have these technologies on their phones. Other positive aspects of QR codes is that they can easily be shared with others and are generally faster to use than Bluetooth, however, this is something that is improving [24]. The negative aspect of using the QR codes mentioned in their first study [5] was that the user still had to check-in at an SSK before going to the room. In their second study [9], they managed to remove this extra step by using encrypted steganography quick response (ESQR) codes. Removing this step resulted in better-perceived seamlessness. The research showed that the ease of use and usefulness of their system contributed to greater seamlessness in hotel check-in and room access. It can be said that with a mobile application, the same level of seamlessness can be reached with an even higher level of security for the users.

2.3 The effects of new technologies on hotel guests

This section describes how technologies similar to the digital key were perceived and used by hotel guests when they first came out by using either the Technology Acceptance Model (TAM) or the Unified Theory of Acceptance and Use of Technology (UTAUT). These two models study the effects of new technologies on society.

Morosan et al. [13] discuss the adoption of NFC mobile payments by hotel guests. The paper uses UTAUT to research how hotel guests will respond to using this new technology. They found that the expected performance of the new technology influences the intention to use technology the most. The higher the expected performance is the higher the intention to use the technology. Furthermore, they found that hotel consumers are ready to learn to use any system, no matter how complex, as long as the system has an excellent performance in task completion. In terms of privacy concerns, they found that consumers who generally have privacy concerns will also show these concerns with particular systems like NFC mobile payments. Privacy is hard to define as there is not a clear line that can be drawn, it is an ongoing process that also depends on the environment in which a user is situated [17]. In this thesis, the general privacy concerns of hotel guests are mainly about losing personal information. Providing personal information to the hotel is in itself not a problem for guests, but with the current number of data breaches and constant hacking, there are often some general concerns around losing personal information. Morosan et al. [12] therefore suggest that even though hotels cannot do much to reduce the general privacy concerns of their guests, they can make sure to communicate in simple terms the privacy rules that the hotel follows and what the implications and advantages are when using a certain technology. Another finding was that general privacy concerns and perceived security does not

directly influence consumers' intentions to use such a system. However, they do influence how consumers feel about specific systems. Therefore, hotels need to be transparent in describing their security practices as this will compensate for the general privacy concerns of hotel guests, which will lead to higher intentions to use such systems.

Morosan et al. [12] focus on the factors that influence the willingness of consumers to disclose personal information via hotel apps to create a more personalized stay. They mention that there is a strong positive relationship between the consumers' trust in the hotel app and their willingness to disclose information via hotel apps. Similarly, the consumers' trust in the hotel positively influences their trust in the application of the hotel. There was, however, no direct significant relation found between the trust in the hotel and the willingness to disclose information. Furthermore, the study found that the perceived value of disclosing information positively influenced the willingness to disclose this information. It was also interesting to see that there was a strong relation between positive emotions related to using the hotel app for personalization and the perceived value of information disclosure. In contrast, negative emotions did not have a significant relationship with the perceived value of information disclosure. Finally, the perceived benefits of information disclosure positively influenced the perceived value of information disclosure, while perceived risks will have the opposite effect. Morosan et al. [12] state that hotels should focus on designing apps that are perceived as trustworthy, stimulate positive emotions, are attractive, easy to use, in sum, creating an enjoyable user experience. To reduce the perception of risk, hotels should inform users of how the information provided will be used. Their study shows that when designing a hotel application feature such as a digital key, hotels must inform their guests on the safety measurements and privacy regulations that they have taken.

The two papers discussed above show that privacy concerns and perceived risks are essential to take into account when designing a technological-intensive feature for a hotel app, especially when the technology is still rather new.

3 METHOD

The literature review has shown why hotels are starting to implement digital keys, but it has also shown the obstacles that hotels face when implementing a new technology. The method that is described in this section addresses the gap in the current research.

This project follows a research through design approach [30]. This approach supports designers in using research to create a product that will transform a current state into an improved future state. Zimmerman et al. argue that the design process in itself can be seen as a result of the research. The design process of this thesis was used to generate different solutions for the digital key and check-in process that are both perceived as safe and convenient to use.

3.1 Semi-structured interviews & thematic analysis

I started the research by conducting semi-structured interviews to find out what the current feeling of safety is of hotel guests when using a digital key and what influences this feeling. The interviews were semi-structured because these tend to be more in-depth and flexible, which makes them more appropriate to collect data about the experiences, perspectives, and feelings of individuals [10]. I recruited the participants by using the snowball technique [14], the requirements for the participants were that they visited a hotel at least once in the last 6 months. This was done to make sure that they were familiar with the latest check-in procedures of hotels.

A total of 20 participants were interviewed of which 11 identified themselves as men and 9 as women. The ages of the participants range between 19 and 61 years old, with a median of 25. The participants' nationality is from 9 different countries throughout Europe. The majority of the participants are either Dutch (35%) or Swedish (20%). The other participants were from, Poland, Spain, Bulgaria, Romania, Italy, Greece, and France. In order to gain insights from all the participants, I included a set of questions for the interviewees who never used a digital key before. These questions were either focused on technologies that are similar to the digital key or on their expectations for the digital key. These similar technologies were mobile payment apps, shared mobility apps, or QR codes that can be used on a mobile phone to open a gate at a train station, airport, or festival.

The interviews were all conducted online, as this research was done during the Covid-19 pandemic. Different programs were used in order to do the interviews, either Zoom, Skype, or Facebook messenger was used. All the interviews were recorded and transcribed. A consent form was signed by all participants.

Thematic analysis was used to construct knowledge by analyzing the interview data. This is a common method when analyzing qualitative data. The first step is to have a research question in mind to generate themes around that can help to explain people's experiences or perceptions of the topic. After the research question is defined, the data is coded and divided into themes. Finally, the generated themes are discussed [2].

3.2 Analysis of textual user reviews

Vasa et al. [26] analyzed 8.7 million reviews from 17,330 apps and found that users will leave longer reviews when they rate an app poorly, however, most users will leave short but informative reviews. For the hospitality industry, it was found that good review analysis can help to recognize business opportunities, while low ratings and bad reviews can influence revenues and limit growth [27][29]. As it was difficult to get in touch with participants that had already used

a digital key before, an analysis of textual user reviews from four different applications that already use a digital key was added. This analysis is a good resource when interviewing users can be more difficult.

I collected the reviews from both the Apple app store and the Google Play store by using a Node.js script that is publicly available on GitHub²³. The applications analyzed were: Hilton Honors, MGM Resorts, Hyatt, and Marriott Bonvoy. I gathered the reviews on the 21st of April 2020 with the oldest review being from the 21st of November 2019, making the total time span of the reviews collected 5 months. It was not possible to collect reviews that were published before the 21st of November 2019. This was the maximum number of reviews that the stores allowed, which resulted in a total of 2343 reviews.

Once collected, I selected the reviews that were related to the digital key by sorting out the ones that contained the words "key", "door", or "open". This resulted in a total of 160 reviews, which I then carefully read and categorized based on recurring patterns. I also tried to select reviews that contained the words "safe", or "secur", but there were no reviews that related to the digital key with either of these words.

3.3 Design process

Based on the insights from the literature, interviews, and review analysis I started with the design of the application. First, I used a brainstorming exercise to open a creative space. During this exercise, I wrote down different features and ideas for the check-in process and digital key. Furthermore, I created a mood board that included screens of existing applications. I translated these ideas into various sketches on paper, which I then discussed with a UX Designer at The Mobile Life. I created a total of 14 different screens, but for every screen and the different features I sketched multiple solutions. Besides the check-in process and digital key, screens were created for other parts of the application as well, these are discussed in the findings section. Based on the Lo-Fi prototype and previous insights I created the Hi-Fi prototype in Figma⁴. I used the current website of the client to define the color scheme of the application. After the first iteration, I discussed the design with a UX Designer and a product manager at The Mobile Life once more. After this session, the final prototype was created, which consisted of 16 different screens.

4 FINDINGS

4.1 Thematic analysis

A total of five themes were generated during the thematic analysis. The research question that the themes depict is:

²³<https://github.com/facundoolano/app-store-scraper>

³<https://github.com/facundoolano/google-play-scraper>

⁴<https://www.figma.com/>

Which aspects are important to understand when designing a digital key for hotel guests to enter in their room? Besides the general design, the focus during the interviews was mostly on the perceived safety. Quotes of the participants are used to exemplify the themes, the participants' names are anonymized and are identified by the pseudonyms Anna, Chloé, David, Robert, and Mia.

New normal

The moment when technologies that are seen as new become a part of people's (daily) life, they become the "New normal". All of the participants had used their phone to open a gate at least once, this was often either at the airport or at the train station. For 10 interviewees using their phone to open gates or to pay in stores was already part of their daily routine. It was interesting to see that many of them even didn't realize how often they use their phone and how much trust they already put in their devices every day. When I asked Anna about her experience with using her phone to open gates she said, *"That always works, actually it's stupid that I still print it out to be sure. I use my phone for these things actually more and more now that I think about it, it works very well."* Other participants had a similar reaction when asked about the different times they use their phone for these purposes.

Fear of change

"Fear of change" is the fear that some people have to change their daily routines for the potential benefits a certain technology has. Even though all of the participants had used their phone to open a gate at least once, nine of them mentioned that they do not like to "rush" into digitalization. They all have a phone and use it, but tend not to download a lot of applications. Of those nine participants, six prefer having something physical like a card to pay or a key to open and close doors. The main reason for this behavior was a feeling of safety with physical objects that they do not get when using something digital and the fact that they don't see many benefits that justify the change. When I asked Chloé if her opinion on mobile payment technology usage would change over time she said, *"I don't see myself using it any time soon, maybe if I see some crazy benefits that I don't have otherwise, but I think having everything digitized is a bit too much."* This answer was very common with these nine participants and showed that the main reason for them not to use certain technologies was the lack of clear benefits they would present.

The importance of UX

From the interviews, it became clear how important UX was for the interviewees and that it has the potential to influence their behavior. All of the interviewees shared their frustrations with applications that have usability problems. Four participants mentioned that the performance and usability

of an application influence their future use of that application. Thirteen participants mentioned that they have had many bad first experiences with applications, either the login didn't work, setting up an account was too complicated or the onboarding process was very long and frustrating. This caused some of them to drop out and delete the application before really using it. Another common problem mentioned was the lack of system feedback in some applications. David told me about his experience while using a digital key and he said, *"When I was inside the room, I was like, is it locked? is it not locked?"* Clear system feedback in an application is important to inform the user of what is happening. In this situation, neither the application nor the lock itself showed if the door was closed or not after entering in the room causing David to feel insecure.

Plan B

Travelling can cause some level of stress, and making sure that all travel documents or phone batteries have a back-up can give some peace of mind. All of the participants used their phone when traveling by train or plane and mentioned that they never had any issues. Still, six of them also printed the boarding pass just in case. This shows that although it always worked for them, they still like to have a back-up in case something goes wrong. This is essential when dealing with traveling and the possibility of missing a flight. While checking-in for a hotel might not be just as daunting if something would go wrong, it is still important to have a plan B ready. Robert told me that the bike-sharing app Mobike has a back-up option when scanning the QR code does not work, he said, *"I think Mobike is very well made if the QR code does not work to unlock you can also write the number of the bike."* The interviews showed that currently people seem to prepare a backup plan themselves, but as shown in the example of Mobike it can be something that is done by the design.

(Dis)trust

While talking to the interviewees about their perceived safety of certain applications, they often started talking about their trust in the companies behind these apps. Many apps nowadays require a lot of personal information of the users and when the company that owns the app is unknown or has a bad reputation it can influence the behavior of the users. One participant mentioned that there are currently many travel and shared mobility apps that require a credit card to be used and that it depends on the reputation of the company to decide whether to put a credit card number or not. Another participant mentioned trusting the Apple App store or Google Play store to only show applications that are safe to use. When I asked Mia about her experience with an E-scooter app she said, *"I feel a bit less secure as I don't really know this company compared to SAS for example, I feel like I can trust SAS more."* These E-scooter companies are quite new and she felt less secure about using their app

compared to using an application of SAS, a well-established airline company in Sweden. The interviewees seemed to have many different opinions on this subject and this shows that it is important to keep different perspectives in mind when designing an application. However, it also shows that not only design is important for users to feel safe.

Reflection

These themes paint a picture of the different aspects that are important to understand when designing a digital key. "New normal" shows that new technologies can be adapted fast by a part of society and become a new standard. For digital keys, this moment has not been reached yet, but will eventually come. Two interviewees mentioned that when using the digital key for the first time it felt 'luxurious' or even 'a bit like magic'. Another interviewee mentioned that this was the case when paying by phone for the first time. Interactions like opening a door or paying in a store are done frequently and will likely soon become the "New normal".

The theme "Fear of change" shows that not everyone is ready to continuously adapt to the new technologies that are generated. For some users, a technology has to prove its benefits first and be tested by a larger part of society before they will consider to also start to use it. This is in line with the Diffusion of innovations theory by Everett Rogers [23]. He argued that there are five different groups of technology adopters. It is therefore important to create applications that are designed to give these users everything they need and expect. Having a bad experience with an application can cause multiple users to stop using it, which is why the theme "The importance of UX" was generated. It was interesting to see that clear feedback was often missing according to the interviewees, even though this is one of the UX principles that were generated by Don Norman in 1988. These principles should be a standard, but they are sometimes forgotten by companies nowadays [16].

Another aspect that has to be kept in mind when designing a digital key is the reliability of the technology. Furthermore, giving users the option to recover from an error or failure. "Plan B" shows that users tend to think of ways to prevent everything from going wrong when one thing fails. Including a feature in the design that would allow to completely or partly solve a problem that might arise is a challenge but will likely be appreciated by the users.

Finally, the theme "(Dis)trust" shows that there are many different factors from the outside that can influence the perceived safety of an application. Making sure that the design is able to address these factors by showing the right information and making sure the users are well informed can help to take away some of the uncertainty that the guests might have.

4.2 Reviews

Analyzing the reviews allowed me to collect interesting insights. The reviews that are discussed in this section contained the words "key", "door", or "open". These reviews were often either complaints about the digital key not working or still having to go to the check-in counter upon arrival. It became clear that during the online check-in there was often no identification process. In some countries, this can be done with a credit card, but even then the guests still have to pass by the check-in desk to show an ID sometimes. Consequently, users said that the application was "useless" as the online check-in was the main reason to download the application. The physical ID check also caused many users to mention that even with the online check-in they still had to wait an hour in line. When the online check-in and digital key worked, the reviews were very positive and the guests loved these features because of their efficiency and ease of use.

Many of the users said that the key was working at first but then after a while, it crashed. Sometimes they couldn't find their booking anymore, or they were randomly logged out of the app. Solutions to add a booking manually (e.g. by filling in the booking reference and last name) were often not there and they had to uninstall the application and install it again. Sometimes users were not sure whether the digital key was working or not because the application was very slow and there was no system feedback. Applications being slow and needing a lot of time to open the door was something that multiple users experienced. Two reviews mentioned that the key was hard to find in the application and that it took too much time to find the key to use it. One of them had to enter the booking reference every time in order to use the key, even while being logged in. Some of the hotels have locks that use normal Bluetooth and not Bluetooth Low Energy (BLE) to be opened, which means that the guest can open the door with more distance to the lock. This resulted, however, in the problem that sometimes the wrong doors are opened as the key doesn't let the guest specify which door to open. This happened only with the doors to the gym or the spa and not with other guests' rooms.

Five users also mentioned that they would like to see this feature working on a smart watch, which was also something that was mentioned by two of the participants during the interviews. At the time in which the reviews were created, none of the applications would let users share the key with others. This caused some problems for the users as not everyone always comes back at the same time to the hotel room. Hilton Honors recently updated its application and made it possible to share the key with one other user.

Some of the reviews mentioned that the digital key is convenient because it is less likely to forget a phone instead of a normal key. It also became clear that showing the bill

of the hotel stay in the application is very important for business travelers especially. Finally, none of the users talked about having any safety issues while using the digital key. Two reviews also mentioned that *"The less interaction with humans the better"*.

The most important takeaways from this analysis were that the currently existing digital keys and online check-in processes do not always deliver what is expected by the users. Users often had to check-in physically to identify themselves which made the app "useless" for them. Thus, a way to identify someone through the application is necessary. The digital key also seemed to crash sometimes or simply disappear, options to recover from these problems were often not given. This is why clear system feedback is needed to give users the right information to solve potential errors. It is also important to mention that the digital key and online check-in are for most users the main reason to download the application. The digital key being slow or hard to find is also something important to keep in mind. Finally, when the digital key and online check-in work, the guests love them.

4.3 Technical implications

Before starting with the Lo-Fi prototype it is important to also take the technical implications in mind. Hotels can use different lock companies to create the digital key with. For this project, The Mobile Life and their client decided to work with the lock company SALTO Systems. The documentation from SALTO Systems [25] shows that the locks can be opened by using Bluetooth Low Energy (BLE). As BLE is not active all the time due to its low energy, users need to tap their phone on the lock to activate it. This makes the interaction similar to paying with NFC or using the traditional key card. This is important to take into account when designing the digital key. Furthermore, the sharing of the key is currently not possible, because the key is connected to the phone number that made the reservation.

4.4 Lo-Fi Prototype

For the Lo-Fi prototype, I created a total of 14 different screens. For the digital key, I created a few different design options. The first design shows a button that needs to be pressed in order to start the unlocking process. In the second design, the key is already activated when opened and no extra button needs to be pressed. I decided that the second approach would make more sense as it was quicker to use and resembled more the use of a normal key card. Furthermore, to make sure that there was enough system feedback I decided to show the unlocking process at all stages. This was done with text in combination with an animation. Finally, to understand how to use the key a button can be pressed to show instructions on a pop-over screen. However, in the final iteration, I decided to delete this button and to instead show the instructions on the screen at all times. A more

detailed description of the different screens is given in the next section.

4.5 Hi-Fi Prototype

For the Hi-Fi prototype, a total of 16 different screens were created. Figure 1 shows the screen where the user can decide to add their ID card. The user is given the option to either add their ID card or to show it at the counter on arrival. Furthermore, an explanation is provided on why the user should add their ID card.

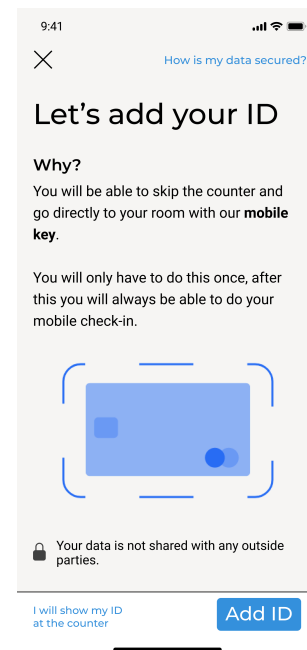


Figure 1: Add identification screen.

Figure 2 shows that the key is placed inside the tab bar to make fast access possible and in the middle as it is seen as one of the most important features of the app. As mentioned before the key can be used immediately once it is opened, this way the interaction is similar to a normal key card. Figure 2 shows the sequence of screens that the user will see when unlocking a door. Both system feedback and instructions on how to use the key are visible for the user. After opening the door the users are notified when the door is locked again.

In Figure 1 and Figure 2 there is a link in the right upper corner that explains more about the technology and how these features are made secure. This is done in order to give users that are worried about safety the opportunity to read about the measures that are taken by the hotel and to feel safer. As mentioned by Morosan et al. [13] this could potentially alleviate some of the worries that certain hotel guests have.

In the introduction, the term seamlessness was introduced as a term that defines the level of ease at which the guests

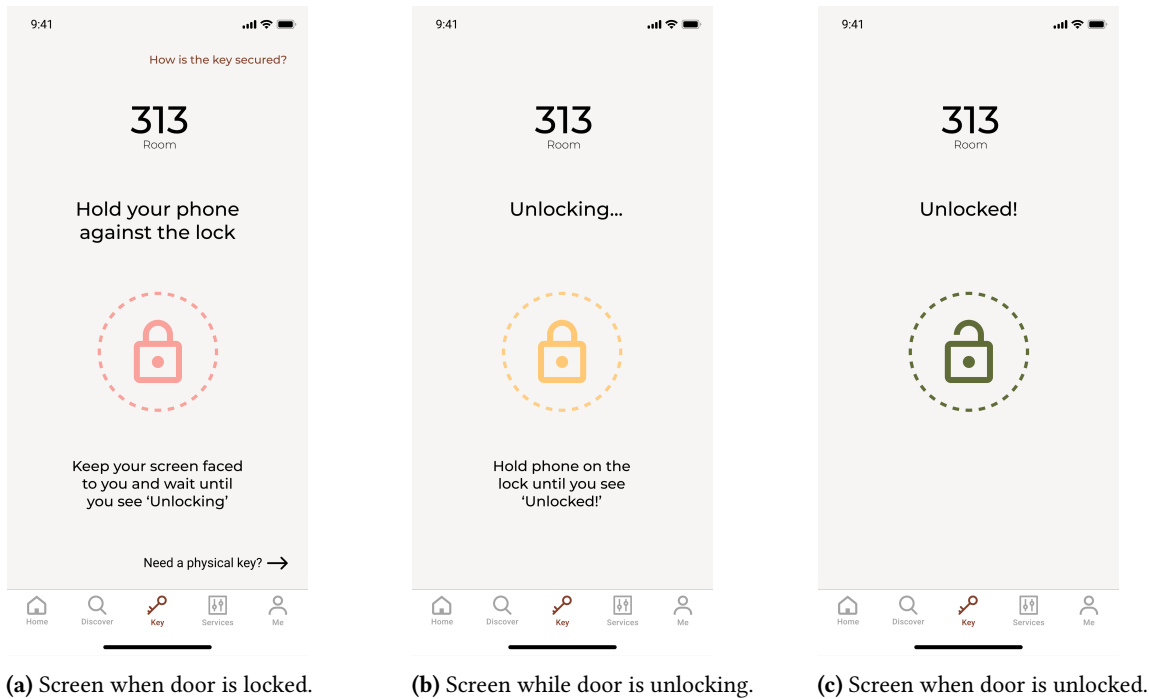


Figure 2: Digital key screens while unlocking a door.

can go from the check-in to arriving inside their room. Although this is an important part of the complete user journey, the design decisions explained above are focused on creating a seamless design instead. According to Höök et al. [8] seamless design is focused on making sure that the users can see all the data, processes, and transitions that are happening within the application to make sure that they understand what is happening and are able to take advantage of this. This is exactly what is done for the digital key in this design, showing at every step of the unlocking process what is happening, which makes this part of the design more seamless, while the complete user journey is more seamless compared to the traditional check-in process that includes the physical check-in at the counter.

Design decisions

The other screens are not shown in this paper due to space limitations, however, the main design decisions that were made for these screens are described here. The decisions were made based on the interviews and the review analysis.

Some interviewees mentioned that an overview of the access history can be useful. In the design under the tab "Services" I decided to add a screen called "Security settings". In this screen the user can decide to receive notifications when someone enters in their room when they are not in the room themselves. The user can also decide to only receive these notifications when housekeeping staff enters or to not receive any notifications. By default these notifications

are turned off. Furthermore, the user can decide to hide the room number in the app. This was done for users who are afraid to lose their phone and that someone will use it to get into their room. By default the room number is shown as it is needed during the first days to find the room.

During the interviews different existing hotel services came up that can be incorporated into the application. One of these services was the "Do not disturb" hanger on the door. Therefore, I decided to add a "Do not disturb" button in the "Services" tab. Another service that was mentioned is the housekeeping. Seven interviewees mentioned that it would be useful to be able to plan or see when their room will be cleaned. I decided to add a notification on the home screen that shows when the cleaning will take place that day. This notification can be clicked to alter the time or add any requests. Under the tab "Services" the guests can also request a room cleaning at any time. Under this tab the users can also find a button to chat with the concierge and a button to request anything that they might need, such as a charger, a toothbrush, etc. Finally, room service can also be found in this tab.

Three interviewees mentioned that using a physical key would be faster for them as it would take them more time to find the application on their phone, also two of the reviews mentioned that finding the key could take some time. In order to improve this, I designed a feature that would send a notification when the user is getting close to the hotel after being away for the day. Once pressed, this notification

will bring the user immediately to the "key" screen after unlocking the phone. What it means to be close to the hotel has to be defined in several design iterations with users. Furthermore, deciding how the app realises that the user was "away for the day" also has to be formed over time. Besides this option, there are different ways to add shortcuts in both iOS and Android that can be used.

Many interviewees mentioned that battery failure could present an issue. While this is hard to resolve completely, a notification can be sent when the battery of the phone is almost empty with instructions on what to do when the phone is off. These instructions depend on the measurements the hotel wants to take. During the day it can be that the instructions say to go to the counter to get a physical key, or if it is busy and there is a queue, there can be a space where users can charge their phone. During the night when there might be no hotel staff, the notification can contain a code that can be used once to enter the hotel and then the users would have the possibility to charge their phone in the lobby to be able to enter in their room. These notifications will also have to be defined in several design iterations with users.

From the reviews it was clear that there was a need to be able to manually add a booking. I decided to have a button called "Add booking" on the home screen. Furthermore, users wanted to be able to share the key, however this was not possible with the current technology. In order to do this I decided to add a QR code that can be scanned at an SKK or the reception to receive a physical key. Once the QR code is shared it can only be used once, however, different QR codes can be send to different users. For business travellers it was important to be able to add a payment method and get a receipt. Adding the payment method is part of the check-in process, but can also be added later in the "Me" tab. Receipts from previous and current stays can also be found under the "Me" tab.

5 DISCUSSION

It is important to keep in mind that the main stakeholder for this project is the client of The Mobile Life who has interests that go beyond usability. However, I focused on designing the application for the hotel guests as user satisfaction goes hand in hand with the hotel's financial interest.

The literature review showed that the current research is mainly focused on the different features hotel apps need, with Chen et al. [4] mentioning that "At Hotel Functions" are the most important features of a hotel app. The results presented in this thesis also seem to suggest that both the online check-in and the digital key are very important for the hotel guests. In the reviews some of them mentioned that it was their main reason to download the application. One of the reasons for this could be that people are using online travel agencies (OTA) to book a hotel. Consequently, these guests will mainly download the app to check-in online and

use the digital key. According to J.D. Power [20], hotel guests that book through an OTA instead of directly with the hotel tend to be less satisfied with their stay and are more likely to experience any problems. Consequently, hotels want users to book through the hotel app. In order to convince guests that booked their room through an OTA to instead use the hotel app next time, the hotel has to make sure that the features that these guests use are designed with their needs in mind as well. This means that if for some reason the booking does not automatically show, the users should be able to add it manually.

According to J.D. Power [20], hotels that incorporate mobile apps into a hotel stay are associated with higher guest satisfaction. Both Gibbs et al.[7] and Neuhofer et al.[15] also argued that technology should be incorporated in every phase of the user journey to be able to increase personalisation and thereby user satisfaction. Even though these articles mention that guests satisfaction is getting higher when hotels implement more technology, this does not mean that this is good for every guest. While some of the reviews mentioned that "The less interaction with humans the better", from the interviews, however, it became clear that for some users the interaction with hotel staff is an important part of the whole experience. According to J.D. Power [22], check-in experiences that on average get a high guest satisfaction score are efficient, accurate, and offer a warm welcome. This shows that a combination of technology and interaction with the staff is important for many guests. Therefore, it can be argued that it is important for hotels to have multiple options as guests can differ.

5.1 Design

The digital key design presented in this thesis is made to be used every day by the guests. This makes it a prominent feature of the app, but at the same time I would argue that this feature should be designed in such a way that it becomes part of the experience and does not unwillingly draw the attention of the guests. This is why I chose to create a fast access to the key and a simple interaction. Both during the interviews and in some of the reviews people mentioned that using the digital key feels "luxurious". While this might be true at the moment this feeling will likely tend to fade away over time and become a "new normal". It is interesting to see that according to J.D. Power [21], hotels that implement a mobile app get on average a 58 point higher score (on a scale of 1000) in 2018, compared to a 65 point increase in 2017. This would suggest that technologies used by hotels such as mobile apps are slowly becoming a "new normal". Consequently, hotels that do not have a mobile app will not be able to meet the expectations that guests will have. Similarly, while online check-in and the digital key are still rather new, I would argue that the hotels should move in this direction before these features become a "new normal".

Perceived safety

One of the main goals of this research was to find out how to design a digital key that provides the user with a safe feeling. At first I thought that many users would have questions about the safety of this new feature and would therefore require extra security measures. However, the results showed that the issues related to safety are in this case more based on trust. When there is trust in the hotel, there is trust in the application. This is in line with the findings from Morosan et al. [12], they found that the consumers' trust in the hotel positively influences their trust in the application of the hotel. The reviews showed that users mainly want to see a key that is easy to use and fast. Still, there is a group of users that is a bit more worried about the safety of new technologies like the digital key. In order for hotels to support this group it is important to have a clear security policy and to communicate this in an easy and accessible way as mentioned by Morosan et al. [12]. Therefore, I decided to add some links in the application, as can be seen in the right upper corner of Figures 1 and 2. These links will bring the users to a page that explains in more detail why this feature is useful and what the security policy is of the hotel. Furthermore, the "security settings" were created to allow the hotel guests to decide for themselves what they want to be able to see and receive. This can give the users a feeling of control and potentially more peace of mind.

5.2 Limitations

Due to Covid-19 the majority of the research was done online. The design process could have been improved by performing brainstorming sessions and discussions in person. Furthermore, if I would have done this research again during different circumstances, I would use a method called *bodystorming*. This method would allow me to explore how it is to physically be at the hotel and I would be able to enact the unlocking of the door. Furthermore, a demo day with the lock company SALTO Systems was cancelled. I would have used this demo day to be able to explore the interaction with the lock.

5.3 Future work

The design created in this thesis has opened up new directions to be explored. One interesting idea that was mentioned by five users in the reviews is to design the digital key for a smart watch. Both smart watches or other wearables are an interesting direction to investigate further. Another interesting direction would be to use the "Security settings" created in this thesis and to see how hotel guests will choose to set them. It would be interesting to see if changing the default settings will influence the behaviour of the users. One current issue with the "Security settings" is that it might suggest that people can enter in the room and this is of course not something a hotel wants to suggest.

It would be interesting to see how the design created in this thesis would be used in a real-life setting. In order to investigate this, the design needs to be implemented and tested with real locks. Furthermore, the physical interaction with the application while opening the door is interesting to explore further. As mentioned before, the goal of this design was to make the interaction as similar as possible to using the more traditional key card in order to make it easy to learn. The introduction of new technologies, such as 5G together with improved face recognition software could potentially disrupt this market. This can be done by allowing cameras to register guests when they are inside the hotel, once they are close to their room the door can be opened automatically. The EU has ongoing discussions on the General Data Protection Regulation (GDPR) and how this will be applied to AI data processing [28]. Following these discussions, I do not think that this will happen within the next 5 years.

Finally, another aspect that should be taken into account is the feedback presented to the user. At the moment this is done only by visual feedback, but sounds and haptic feedback are other options that can be explored as well. These two modalities can be used either in the phone or in the door itself, LED-lights can be used to show if the door is locked or not. Besides the existing screens, future research can investigate the influence of different error screens to make sure that they provide the user with the correct feedback to solve the issue at hand.

6 CONCLUSION

This paper aimed to create a digital key and online check-in process that are both easy to use while also being perceived as safe. The findings showed that people are not very worried about safety as there is a lot of trust in the hotels. Instead, most users want to have a digital key that is easy to use and something they can rely on. The thematic analysis showed different aspects that need to be taken into account when designing a feature for a hotel application. From the reviews it became clear that the online check-in process needs a way to identify the user to make sure that the counter can be skipped. Furthermore, users mentioned that the digital key needs to be fast and provide clear feedback. While hotels should do their best to address these needs, they should not forget the human interaction that many guests enjoy in hotels. It is therefore important that hotels keep in mind that guests can differ and that there should be different options available. The interviews showed that new technologies can become a "New normal" rather quickly. With mobile apps slowly already becoming the standard instead of an added luxury in hotels, I would argue that hotels start to implement both the online check-in and digital key. The design presented in this research can be used as a starting point for hotels when developing these features.

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