**ABSTRACT**

This dissertation research project examines the self-checkout processes used in retail shops/supermarkets which are widely used to enhance the customer experience during in-store shopping as well as in the checkout process. Still, Retailers find it difficult to implement those since the technology relies completely on the retailer’s terminals, space availability as well as financial requirements for this implementation. This research approach incorporates the self-checkout functionality in a mobile application where the embedded camera act as the barcode scanner to scan the products & add the products to the shopping cart simultaneously while adding it to the physical cart and making the payment through the mobile application itself through online payment Gateway. With the Mobile Application, the research primarily addresses customer experience enhancement and the waste of time spent on billing and checkout in the shop. Incorporating evidence from user evaluation through Survey questionnaires, the customers, as well as the customers, are satisfied with this approach and the adaptability towards this approach is influenced by the user’s existing system for the checkout process.

*Keywords*: self-checkout, self-service technology, Retail, Mobile payment.

**ACKNOWLEDGMENT**

I would like to express my deepest gratitude to the Supervisor, Mr Cogill Peter for his constructive feedback on each phase of the research. This endeavor would not have been possible without his guidance throughout with new insights into the research. I would like to extend my sincere thanks to my Classmates and friends for helping me with any clarification that occurs often with writing, and moral advice and to the Study participants for taking their valuable time to provide their significant feedback.

Special thanks to my partner for his continuous support and motivation throughout this journey. Lastly, I would like to mention my mother for her Belief in me and the emotional support she has showered me even from miles apart which helped me to be focused.

**TABLE OF CONTENT**

**ABSTRACT**

**ACKNOWLEDGEMENT**

**INTRODUCTION**

**INTRODUCTION AND JUSTIFICATION**

**PROJECT RATIONALE**

**RESEARCH AIM**

**RESEARCH QUESTION**

**RESEARCH OBJECTIVES**

**PROJECT DELIVERABLE**

**PROJECT SUCCESS CRITERIA**

**LITERATURE REVIEW**

**INTRODUCTION**

**SELF SERVICE TECHNOLOGY**

**SELF CHECKOUT SERVCES**

**SELF-SERVICE TECHNOLOGY AND SERVICE QUALITY**

**CUSTOMER SATISFACTION**

**CUSTOMER LOYALTY**

**SHOPPING EXPERIENCE WITH THE CURRENT SYSTEM**

**SELF CHECKOUT KIOSK**

**BARCODE SCANNER HAND HANDHELD DEVICE (SCAN AND GO)**

**SELF-CHECKOUT WITH RFID TAG**

**AMAZON GO**

**MOBILE PAYMENT / M-PAYMENT**

**EVALUATION CRITERIA**

**LITERATURE REVIEW SUMMARY**

**RESEARCH ON THE MOBILE SELF CHECKOUT SYSTEM ADOPTION**

**RESEARCH DESIGN**

**INTRODUCTION**

**RESEARCH PHILOSOPHY**

**RESEARCH APPROACH**

**METHODOLOGICAL CHOICE**

**RESEARCH METHODOLOGY**

**RESEARCH STRATEGY**

**RESEARCH TIME HORIZON**

**TOOLS AND TECHNIQUES**

**PROJECT MANAGEMENT METHODOLOGY**

**MOBILE APPLICATION REQUIREMENT ANALYSIS**

**FUNCTIONAL REQUIREMENT**

**USER INTERFACE**

**NON FUNCTIONAL REQUIREMENTS**

**SOFTWARE AND HARDWARE REQUIREMENTS**

**KOTLIN**

**ZXing LIBRARY**

**PayPal Testing API**

**SOFTWARE DEVELOPMENT KIT**

**FIREBASE**

**RESEARCH ETHICS**

**RESULTS**

**DISCUSSION**

**CONCLUSION**

**SELF-CHECKOUT IN RETAIL SHOPS USING THE MOBILE APPLICATION**

**CHAPTER 1**

**INTRODUCTION**

**1.1 INTRODUCTION AND JUSTIFICATION**

All over the world, technological implications are helping to reduce human effort thereby saving time spent also. As a result, each sector/industry tries to implement technological innovations in day-to-day activity (Swamy, Rao, Sharath, Gupta, & Rakesh, 2019). People all over the world love shopping, especially when the quality of service provided is of a high standard. With the development of technology, there is a strong desire to reduce human labor. Even though the style of shopping is improved from the past and still improving, the traditional method to pick the products in a shopping trolley and waiting in a queue to make the bill and payment is still followed to a certain extent in the shops making the customers feel stress and discomfort (Belibov & Tudose, 2019). Most of the time even for a single product, they have to follow the same procedure as everyone and occasionally there may be issues with many different billing counters, which would briefly stop working, forcing everyone to leave, and there would just be one billing counter remaining (Nishitha, Naik, Raksha, & Kulsum, 2019). Also, often customers face the issue of calculating the total amount to be paid, and whether it fits within the budget they have (Moe & Mon, 2019). To tackle this issue, the shopkeepers also have to include more human resources and space for more bill counters (Ahmed et al., 2021). Currently, barcode scanners are widely used for the same purpose, which enhanced the customer experience to a certain extent. But still, time needs to be spent in the queue for checkout and billing, as the billing can be done only through the till in the shop. In addition to that, with the Covid-19 pandemic consumers prefer to make the purchase and transactions contactless as a safety measure (Ahmed et al., 2021). The goal of this approach is to develop a Mobile Application through which the products can be added to the cart (reading the barcode of each product) as it is purchased, and the payment can be made through the E-payment mode being added in the application. This approach helps to improve the customer experience in a retail store by reducing time, human effort, miscounting, etc.

The term smart shopping is intended for different meanings, it kept on changing from time to time and person to person. According to (Mano & Elliott, 1997) it is the function of enabling monetary savings. Later (Atkins & Kim, 2012) defined smart shopping for consumers to highlight the time and effort savings in the busy world. To obtain hedonic and utilitarian benefits from the experience, the researchers suggest that customers who are smart shoppers strive to limit the amount of time, money, or energy spent (Atkins & Kim, 2012). (Schindler, 1998) describes the utilitarian benefit as emphasizing the importance of consumer efficiency in terms of cost reductions and (Hirschman & Holbrook, 1982) described the Hedonic benefit as the emotional value of a shopping excursion in terms of potential amusement which can include emotions like arousal, satisfaction, and entertainment (R. Li et al., 2017)**.** Nowadays, the hedonic benefits are given more attention to make shopping much more enjoyable and fun, which contributes to, what is meant by smart shopping nowadays. With the help of the Internet of Things (IoT), Physical item interactions are becoming common. Thus, every object can be connected to each other through communication and computational capability (R. Li et al., 2017)**.** With the help of the IoT, day-to-day human life is changed.

**1.2 PROJECT RATIONALE**

In today’s busy world, Consumers value their time and effort savings more than monetary savings. In order to obtain hedonic (emotional values) and utilitarian benefits (consumer efficiency in terms of cost reductions) from the experience, the researchers suggest that customers who are smart shoppers strive to limit the amount of time, money, or energy spent on shopping (Atkins & Kim, 2012). Thus, there is a need to implement technological innovation to reduce consumer time and effort spent on shopping so that Customers will be able to spend their time in a more effective way or personally. To address these problems, many self-service technologies are already available but most of them are too expensive requiring the technologies such as autonomous shopping baskets, and baskets with cameras and sensors to work well with each other to automate the shopping experience (Belibov & Tudose, 2019).

In this proposed approach, the mobile application act as the Barcode scanner, to scan the product and can be directly added to the cart as well as they have the power to make digital payment through the integrated Payment Gateway eliminating the long queue.

Consumers can directly download the mobile application from Google Store (being an Android Application) and can use them right away by simply registering it with email, which is cost-effective for the consumers. On the other hand, Shop keepers are not expected to install sensors or fully automated Shopping carts to tackle this issue.

**1.3 RESEARCH AIM**

The aim of this project is to improve the overall shopping experience of customers in a retail shop. In particular, the human effort throughout shopping and time spent on a till is reduced. The project will develop a mobile application that acts as a barcode scanner to add the product to the cart as purchased and make the online payment through the payment gateway integrated into it.

**1.4 RESEARCH QUESTION**

How to reduce the human effort and time during shopping in a retail shop?

**1.5 RESEARCH OBJECTIVES**

To support and achieve the research aim, the below-mentioned objectives are followed,

1. Analyse and Identify the pre-existing smart shopping processes/techniques in the shopping world through Literature Review.

2. Identify and discuss the relevant project management methodology and requirements of the Mobile application.

3. Decide on a suitable platform to develop the Mobile Application.

4. Develop the Mobile Application.

5. Test the Mobile Application with intended users and evaluate their feedback.

6. Evaluate the results of the research projects against the initial objectives and put forward recommendations for future research

Initially, Literature Review was approached to understand the existing research on the smart shopping processes available to get a clear picture of the knowledge gap. Next, to develop the Mobile Application, the Project Management methodology was decided (Agile Methodology) which helps with analysing the functional requirements of the application. Once the methodology and functional requirements are finalized, the next objective was to agree upon the platform to develop the mobile application. Then, the Mobile application is developed followed by testing the User Interface and Functionalities, and feedback is evaluated. The final objective was to evaluate the research project result in opposition to the research aim from the stakeholder’s perspective and determine future research recommendations.

**1.6 DELIVERABLE**

A Mobile Application will be developed to enhance the experience of shopping through smart shopping.

**1.7 PROJECT SUCCESS CRITERIA**

This project can be considered as successful when customers spent less effort and time than the existing process, during physical shopping using the mobile application being developed.

**CHAPTER 2**

**LITERATURE REVIEW**

**2.1 INTRODUCTION**

This chapter provides an overview of the existing knowledge of self-service technologies, and their adoption rate, particularly with the self-checkout services available. It further focuses on the types of self-service technologies widely used along with their limitations, pros, and cons. Finally, the evaluation criteria are included to understand the work better.

**2.2 SELF-SERVICE TECHNOLOGY**

Self-service technology (SST) refers to systems and technologies that allow customers or users to access information or services independently, without the need for direct assistance from a human representative (Curran & Meuter, 2005). As a result, these technologies are widely used in industries such as retail, hospitality, and transportation (McWilliams, Anitsal, & Anitsal, 2016). In addition, (Mukerjee, Deshmukh, & Prasad, 2019) addressed, SSTs are popular among retailers because of their quick and precise service, customization, comfortability & efficiency, cost savings, increased market share, competitiveness, customer satisfaction, and loyalty. Similarly (Elliott, Meng, & Hall, 2008) pointed, out that with SST customers can be retained to a certain level. (Bitner, Ostrom, & Meuter, 2002) present findings from qualitative interviews and survey research investigating SSTs from the customer's point of view. On the other hand, (Meuter, Ostrom, Bitner, & Roundtree, 2003) explore usage patterns and benefits of using self-service technologies (SSTs) based on a sample of 823 consumers. As well, (Gerrard & Cunningham, 2003) identified eight characteristics that influenced the rate of adoption. To better understand consumers' intentions to utilize SSTs, (Curran, Meuter, & Surprenant, 2003) furthermore, created and empirically evaluated three-tiered structural models that incorporate a hierarchy of customer attitudes toward both the interpersonal and technological parts of the encounter. Above all, (Yen & Gwinner, 2003) proposed a conceptual framework that utilizes the construct of relational benefits to explain the link between Internet‐based self‐service technology attributes and customer loyalty and satisfaction.

Key examples of self-service technology include automated teller machines (ATMs), automated hotel check out, kiosks, self-checkout systems at retail shops, and online booking systems that enable users to perform tasks on their own, such as booking a flight, purchasing goods or services, or accessing information (Curran & Meuter, 2005). It follows that, Customers benefit from the fun of using technology, increased personalization, time and cost savings, shorter wait times, and greater control over service delivery (Dabholkar, 1994). Whereas the firm’s aim for approaching the SST is to achieve Customer Service primarily and enable direct transactions (Hsieh, 2005).

**2.2.1 SELF CHECKOUT SERVICES**

Self-checkout services are a type of self-service technology that allows customers to scan, bag, and pay for their own items at a retail store, rather than going through a traditional checkout lane with a cashier (Elliott, Meng, & Hall, 2008). There are many types of self-checkout that already exist and each one has its own features. Such as Self-checkout Kiosks, Scan and go with Barcode scanner handheld device, self-checkout with RFID, amazon go, etc.

**3.2.2 SELF-SERVICE TECHNOLOGY AND SERVICE QUALITY**

Rapid technological advances have a significant impact on how retailers deliver their functions and remain competitive in globalized markets. These technological advancements are drastically altering how consumers engage with retailers and how retailers deal with their clients, although retailers have been using SSTs for some time and interest in SSTs is not a new concept, measuring and evaluating the value of SSTs is becoming increasingly important as retailers expand their offerings and more customers use such services. (Demirci Orel & Kara, 2014). According to (Giesen, 2012), people under the age of 45 prefer to avail the self-services available in a retail shop. While retailers are motivated to adopt SSTs for cost savings, efficiency, flexibility, productivity, and improved corporate performance (Lee, Fairhurst, & Lee, 2009), it is crucial to investigate customers' shopping experiences and service quality expectations of self-checkout systems (SCS) in order to understand the improvement of retailer service performance, customer satisfaction, and loyalty.

Examining how technology-based services, or SSTs, affect customer satisfaction, loyalty, and behavioural intentions in the service industry was the fundamental goal of (Shahid Iqbal, Ul Hassan, & Habibah, 2018). (Ahn & Seo, 2018) investigates the relationship between consumer’s perceptions of the features of interactive restaurant self-service technology (IRSST) and their cognitive and affective states, as well as the behavioural intentions that follow. (Ahn & Seo, 2018) investigates how consumers' opinions of interactive restaurant self-service technology (IRSST) features affect their cognitive and emotional states, as well as the ensuing behavioural intentions. This subject of (Leon, 2018) is to evaluate Millennials’ intention to use service mobile apps and assess gender as a moderator. The primary goal of (De Leon, Atienza, & Susilo, 2020) is to determine whether the Self-Service Technology service quality (SSTQUAL) factors have an impact on how valuable mobile banking applications are perceived by customers and how satisfied they are with them. They also cause many problems due to practical limitations.

As defined by (Curran & Meuter, 2005) earlier, SST helps to reduce employee involvement in service, enabling the retailers to reduce the cost related to employees. Similarly (Dabholkar, Bobbitt, & Lee, 2003) put forward that the retailers benefit from SCSs leading to reduced staffing requirements, which leads to lower employee training costs. It is argued by (Dabholkar, 1994) that through SSTs, customers perceive improved service since they are able to complete the transaction more conveniently and quickly. This provides retail firms with cost efficiencies and improved labor utilization, potentially contributing to the retailer's competitive advantage. On the other hand (Hsieh, 2005) explained from the customer’s perspective, who benefits in the form of reduced checkout time, perceived privacy, and faster service. With keen analysis (Sureshchandar, Rajendran, & Anantharaman, 2002) concluded that the two factors that are closely related to service quality are customer loyalty and satisfaction, likewise (Caruana, 2002) considered service quality contributes as an important factor for customer satisfaction. Likewise, The subject of (Demirci Orel & Kara, 2014) is to examine the service quality of supermarket/grocery store SCSs and its impact on customer satisfaction and loyalty in an emerging market.

**2.2.2.1 CUSTOMER SATISFACTION**

Customer Satisfaction has various definitions/meanings by different researchers. Bitner (1997) stated it as the evaluation of customers based on whether the service or product met their expectations, Likewise Kotler & Armstrong (2010) defined Customer satisfaction as a person's emotional state as a result of equating a product's perceived performance or outcome to his or her own expectations. Studies on customer-technology interactions have also revealed a substantial relationship between service quality and customer satisfaction. For instance, (Wolfinbarger & Gilly, 2003) revealed that there are strong relationships between service quality and customer satisfaction in internet retailing. As a result, it is hypothesized that Self-checkout services have a positive impact on customer satisfaction.

##### Empirical evidence is needed to better understand customer expectations of SCS service quality and how technology-based service quality impacts retail patronage. As a result, (Andriulo, Elia, & Gnoni, 2015) propose a comparative analysis of the application of different types of mobile Self-checkout Services (mSCSs) at FMCG retail stores. In addition, (Andriulo, Elia, & Gnoni, 2015) focused on analyzing quantitative impacts on time-based metrics both from the customer and the retailer points of view. In particular, (Morimura & Nishioka, 2016) investigate how expectations about self-checkout affect perceptions of waiting in terms of social injustice, unattractiveness, and undistraction as well as customer satisfaction when retailers change checkout operations through installing self-service technologies. Most Importantly, (Fernandes & Pedroso, 2017) presents a causal model to investigate (i) whether consumers evaluate service quality for self-checkout based on five different attributes: speed, ease-of-use, control, reliability, and enjoyment; (ii) whether the evaluation of service quality differs according to demographics and usage frequency; and (iii) whether service quality delivered by self-checkout is related to overall customer satisfaction and retail patronage. In the retail sector, such technologies often provide decision support as the main purpose (information terminals) or side effects (self-scanning). Indeed, (Djelassi, Diallo, & Zielke, 2018) explored whether the SST type moderates the processes as well as how SST experience rating affects customer happiness with the business indirectly through the mediation of waiting for time satisfaction and contentment with SSTs. Lastly, (Rinta-Kahila, Penttinen, Kumar, & Janakiraman, 2021) examined how self-checkout (SCO) discontinuance affects customers’ perceptions of SCO technology and purchase behaviour.

**2.2.2.2 CUSTOMER LOYALTY**

Pearson (2016) defined Customer loyalty as the mindset of customers who have positive perceptions toward a company, commit to purchasing the company's product/service again, and highly suggest the product/service to others. According to (Zeithaml, Berry, & Parasuraman, 1996) when customers are satisfied with the services provided, certain behaviors arise, such as customer loyalty, willingness to pay higher prices, and a lower probability that customers will complain about the product/service to others. Likewise, a study by (Boulding, Kalra, Staelin, & Zeithaml, 1993) that confirmed the positive relationship between service quality and repurchase intentions backed up these claims. As a result, it is hypothesized that Customer Satisfaction has a direct positive impact on customer loyalty. Moreover, While some studies in the literature have presented evidence to back up the view of a direct link between customer satisfaction and loyalty, others have indicated that the customer satisfaction-loyalty relationship is complicated and that the factors that influence customer satisfaction may vary from the ones that determine customer loyalty (Reichheld, 2001). On the contrary, (Jacoby & Kyner, 1973) confirmed that previous studies used behavioral responses to measure loyalty and argued that satisfied customers would have a higher consumption level of service than dissatisfied customers and are more likely to have stronger purchase intentions and recommend the product to others and in th same way, according to (Kheng, Mahamad, & Ramayah, 2010), high customer satisfaction has a positive impact on a customer's loyalty. To be more specific with this project, (Marzocchi & Zammit, 2006) found that satisfaction with self-service checkouts positively influenced consumers repurchase intention towards a store. Similarly, (Dabholkar, Shepherd, & Thorpe, 2000) discovered that the effect of service quality on behavioral intentions was strongly mediated by customer satisfaction.

(Stank, Goldsby, & Vickery, 1999) present research that examines the complex relationship between service quality and profitability in service operations. However, (Selnes & Hansen, 2001) argue that the decision should be reframed as follows: “How can self-service be integrated with personal service?”(Yen & Gwinner, 2002) proposes a conceptual framework that utilizes the construct of relational benefits to explain the link between Internet‐based self‐service technology attributes and customer loyalty and satisfaction. In addition, (Jong & De Ruyter, 2004) developed a conceptual model of adaptive versus proactive recovery behaviour by self-managing teams (SMTs) in service recovery operations**.** And (Meuter, Bitner, Ostrom, & Brown, 2005) examine significant variables that affect the decision to conduct a first SST trial, concentrating on actual behaviour in scenarios where the consumer has a choice of delivery options.Furthermore, the purpose of (Chang & Wang, 2011) is to examine the impact of e‐service quality, customer perceived value, and customer satisfaction on customer loyalty in an online shopping environment.

**3.3 SHOPPING EXPERIENCE WITH THE CURRENT SYSTEM**

This section covers the overview of the existing self-checkout systems for shopping and the customer shopping experience with them.

**2.3.1 SELF CHECKOUT KIOSK**

A self-checkout kiosk in retail is a type of self-service technology that will have self-checkout machines or self-checkout terminals that allow customers to scan and pay for their own purchases without the assistance of a store employee. These kiosks typically consist of a touchscreen display, a scanner for reading barcodes, and a card reader for accepting payment (Rowley & Slack, 2003). As per (Lee, Fairhurst, & Lee, 2009) Self-checkout kiosks are commonly found in supermarkets, department stores, and other retail settings. The customers are required to purchase the items as usual and at the end, they must self-checkout with the kiosk for payment. Self-checkout kiosks can be convenient for customers who prefer to handle their own transactions and do not want to interact with the cashier. Even though this improves the shopping experience of customers, (Rowley & Slack, 2003) mentioned the limitation, that most often there is a need to wait in the queue to get access to the kiosk being set up for checkout/ payment, also it cannot eliminate the human agents to a great extent.

**2.3.2** **BARCODE SCANNER HAND HANDHELD DEVICE (SCAN AND GO)**

This feature holds an additional functionality to the self-checkout feature. Scan-and-go is a type of self-checkout system that allows customers to scan items as they shop using a handheld barcode scanning device provided by the store, and then pay for all their items at once at a designated checkout area or kiosk.

To use a scan-and-go system, customers typically begin by scanning the barcodes of their items using the kiosk's scanner. The kiosk will then display the items and their prices on the screen, and the customer can pay for their purchases using a credit or debit card, or cash (Cho & Fiorito, 2010). Scan-and-go systems are designed to make the shopping experience more convenient for customers by allowing them to skip the traditional checkout line. They can also be beneficial for retailers as they can reduce the number of staff needed to assist with checkout and improve efficiency. The major limitation of this service includes the limited availability of the technology or say the handheld devices in the store, which makes the shop owners invest more in the devices.

**2.3.3** **SELF-CHECKOUT WITH RFID TAG**

An RFID (Radio-Frequency Identification) tag is a small chip that contains a unique identification number and is attached to an item for identification purposes. RFID tags can be read by RFID scanners and readers, which use radio waves to communicate with the tags and retrieve the identification numbers. Mainly, RFID tags can be attached to clothing, electronics, and other products. However, RFID tags can be more expensive to implement and maintain than other methods of tracking and identification, such as barcodes. As a result, RFID technology is not used in every product or industry.

To use the RFID technology, all the products should have unique identification. Since RFID technology is not widely used for all products, it adds an extra expense for retailers to follow this method. In addition, some products, such as those that are very small or have a short shelf life, may not be practical for RFID tagging.

1. Customers add items to their shopping cart as they normally would.
2. Instead of going to a cashier to pay, they can scan their items using an RFID scanner. RFID scanners are equipped with RFID antennas that emit radio waves, which are used to communicate with RFID tags attached to the items being scanned.
3. The RFID tags on the items contain unique identification numbers, which are transmitted to the RFID scanner when the item is placed near the antenna.
4. The RFID scanner then sends this information to a central computer, which retrieves the item's price and adds it to the customer's total.
5. The customer can then pay for their items using a variety of methods, such as cash, credit card, or a mobile payment app.

**2.3.4** **AMAZON GO**

Amazon Go is a chain of convenience stores operated by Amazon that uses self-service technology to allow customers to purchase items without the need to wait in line or interact with a cashier. Amazon Go stores use a combination of sensors, cameras, and machine learning algorithms to track the items that customers take off the shelves and add to their virtual shopping carts. When customers are finished shopping, they can simply walk out of the store and their purchases will be automatically charged to their Amazon account. Amazon Go stores offer a variety of convenience items, such as snacks, drinks, and ready-to-eat meals, as well as a small selection of grocery items. The stores are designed to be convenient and efficient, allowing customers to quickly grab the items they need and check out without waiting in line.

The major concern with Amazon Go covers the need for significant financial investment, which is not affordable for all retailers to follow. If the store's technology experiences technical issues, it can be frustrating and slow down the shopping process.

**2.4 MOBILE PAYMENT / M-PAYMENT**

Mobile payment, also known as M payment, is defined as the “transfer of funds in return for goods or services in which a mobile device is functionally involved in executing and confirming payment” (Raina, 2015). There are several types of mobile payments, but the technologies used to deliver them can be broadly divided into two categories: remote m-payments and proximity payments (Agarwal, Khapra, Menezes, & Uchat, 2007). With Remote payments, Customers must register for a service, which usually entails downloading an application, and then using it on their mobile device to pay for items. Customers can store money in prepaid accounts or withdraw money directly from their bank accounts. Google, PayPal, and GooglePay are among the payment service providers (PSPs) that use a cloud-based remote approach to in-store mobile payment. Alternatively, proximity payments ask the user to present a credit card, mobile phone, or tablet device at a payment terminal, usually within a few centimeters, in order to complete the transaction (Guha, 2013). Mobile payments are convenient for consumers as they allow them to make payments quickly and easily using their mobile devices, without the need for cash or credit cards. They are also secure, as they often use encryption and other security measures to protect sensitive financial information. Mobile payments are becoming increasingly popular and are accepted by a growing number of merchants, including retail stores, restaurants, and online retailers. They can be used for a variety of purposes, including making purchases in-store or online, paying bills, or sending money to friends and family.

##### The aim of (Karnouskos, 2004) is to introduce the reader to mobile payments, present current concepts and the motivation behind them, and provide an overview of past and current efforts as well as standardization initiatives that guide this rapidly evolving domain. For this purpose (Ondrus & Pigneur, 2006) propose to conduct two disruption analyses to draw the disruptiveness profile of mobile payment solutions compared to other payment instruments. (Mallat, 2007) present a qualitative study on consumer adoption of mobile payments. The consumer perspective of mobile payments as well as technical security and trust are best covered by contemporary research (Dahlberg, Mallat, Ondrus, & Zmijewska, 2008). By expanding the Technology Acceptance Model (TAM) and the Innovation Diffusion Theory (Chen, 2008) propose a research model that examines the factors which determine consumer acceptance of m-payment. The empirical results show particularly strong support for the effects of compatibility, individual mobility, and subjective norm. The study offers several implications for managers in regard to marketing mobile payment solutions to increase consumers' intention to use these services (Schierz, Schilke, & Wirtz, 2010). Mobile payment is anticipated to enjoy a bright future. (Kim, Mirusmonov, & Lee, 2010) suggest new directions for future research in this emerging field. The adoption and use of mobile payment services are critical for both service providers and investors to profit from such an innovation. (Yang, Lu, Gupta, Cao, & Zhang, 2012) attempt to identify the determinants of pre-adoption of mobile payment services and explore the temporal evolution of these determinants across the pre-adoption and post-adoption stages from a holistic perspective including behavioral beliefs, social influences, and personal traits. Drawing on the information systems success model and flow theory (Zhou, 2013) identify the factors affecting the continuance intention of mobile payment.

**2.5 RESEARCH ON THE MOBILE SELF CHECKOUT SYSTEM ADOPTION**

As discussed earlier, over the past few decades, a variety of studies considering factors impacting mobile banking and mobile payment adoption have used DOI (Diffusion of Innovation) as their theoretical basis. Additionally, because financial transactions are included in mobile banking and payment platforms, adoption factors have taken into account concerns like perceived risk, privacy, and security of those transactions (Al-Jabri & Sohail, 2012).

Diagram

Description automatically generated

Source: (Curran & Meuter, 2005)

**RELATIVE ADVANTAGE**

Moore & Benbasat (1991) defined Relative Advantage as the degree to which an innovation is perceived to be superior to its predecessor. Studies conducted by (Johnson, Kiser, Washington, & Torres, 2018) and (Arvidsson, 2014) have shown that relative advantage positively impacted mobile banking service adoption which derives that Relative advantage has a positive impact on usage intention.

**Compatibility**

Moore & Benbasat (1991) defined Compatibility as the extent to which an innovation is perceived to be consistent with an individual's values, needs, and prior experience. In order for an individual to adopt a new innovation, the innovation should be compatible with the individual’s personal lifestyle. SST usage intention and behaviour are positively related to compatibility (Curran & Meuter, 2005).

**Ease of use**

Ease of use is defined as the degree to which an individual perceives the use of an innovation as being possible without mental and physical effort (Davis, 1989). Ease of use has been used in a number of adoption studies and has been shown to be a good predictor of individual adoption. Arvidsson (2014) discovered that ease of use, trust, and perceived security were important predictors of mobile payment service adoption in mobile technology adoption, and on the other hand, Kang et al. (2015) observed that convenience, interactivity, compatibility, and effort expectancy, in addition, to ease of use, were significant predictors of location-based service adoption in a retail setting.

From the above-mentioned studies, It is predicted that Ease of use has positively influenced mobile adoption.

**Trialability**

Moore & Benbasat (1991) defined Trialability as the extent to which an individual has the opportunity to experiment with innovation before making an adoption decision. Folorunso et al. (2010) used DOI to investigate factors influencing social networking technology adoption. They discovered evidence that trialability and compatibility had a positive impact on attitudes toward technology use.

In the study conducted by Odumeru (2013) regarding mobile adoption, It was evident that trialability along with compatibility, relative advantage, and Ease of use acts as significant influencers of mobile banking adoption. Additionally, (Johnson, Woolridge, Wang, & Bell, 2020) concluded that trialability has a positive impact on usage intentions.

**2.5 EVALUATION CRITERIA**

The time spent in the shop is calculated with the overall time required from entering the store to completing the payment. The complete process involved in traditional shopping is depicted in the below figure. The below Figure is also applicable to the self-checkout kiosk setting.

Diagram

Description automatically generated

Figure 1: Processes involved in traditional shopping at a retail store

(Source: (Andriulo, Elia, & Gnoni, 2015))

The total processing time is calculated as mentioned below, which includes the time taken to pick up the products and load them into the cart.

A picture containing text, antenna

Description automatically generated……..Equation(1)

Where *T localiz*is the time taken to locate the items in the supermarket and to move to the next item location (say jth).

*Tload*is the time taken to load the selected item in the shopping cart.

*N Itemi*is the number of items taken in a particular location(say jth location).

And the below equation (2) determines the time taken for the payment process,

Diagram

Description automatically generated

where, Tunload is the unitary time taken to unload the item from the shopping cart; Tid is the time taken to identify the particular product(say to scan the product barcode); Tpayment is the total time taken to do the payment process.

With the Equation (3) gives the time taken to pick up the items and add them to the cart. With adding the products to the physical cart, instantly it is added in the virtual cart also.

A picture containing diagram

Description automatically generated

For the payment process, the customer goes through the virtual cart confirms the items being added and payment is proceeded, which is expressed in the below equation (4)



Where Tconfirmation is the time taken to verify and confirm the products added to the virtual cart before proceeding to the payment.

With the self-checkout, the processes involved in Figure 1 can be modified as and can be represented in figure 2

Diagram

Description automatically generated

Figure 2: Processes involved in the shopping with hand-held barcode scanner and self-checkout kiosk (Source: (Andriulo, Elia, & Gnoni, 2015))

Thus, the total time spent in the shopping life cycle includes the time spent on selecting the product & adding it to the cart, the waiting time in the queue for checkout (which varies depending upon the length of the queue and the number of products purchased by others standing in the queue in front of you) and the time spent for the payment process, refer the equation (5).

A picture containing chart

Description automatically generated------Equation (5)

In figure 2, the process of unloading the item at the cash desk is eliminated as they are added to the virtual cart as they fill in the physical cart itself. According to (Miwa & Takakuwa, 2008), simulation models have revealed an effective, analyzing, technical, and organizational alternative in the retail sector.

**LITERATURE REVIEW SUMMARY**

Traditional in-store shopping has certain drawbacks such as longer and time-consuming checkout queues and thereby customer inconvenience and discomfort. These downsides are common in most retail stores that use a manual checkout system. SSTs (self-service technologies) have become an essential part of consumers' daily lives. Keeping up with the trend, supermarkets around the globe have begun to rapidly adopt self-checkout systems (SCSs). On the other hand, Consumers' responses to such changes in service encounters, may vary significantly and influence their satisfaction with the retailer's offerings. A few systems that have addressed these issues were studied, such as Self-checkout Kiosks, Scan and go, and weigh-and-pay. The study's findings on similar systems include various design strategies that were used to provide a solution to the existing system's limitations. Among these, the Scan-and-go approach integrated into the mobile application is chosen for this project.

**CHAPTER 3**

**RESEARCH DESIGN**

**3.1 INTRODUCTION**

The Research Onion framework, which is also a theoretical concept is adopted for the research design of this study. It was proposed by Saunders, Lewis, and Thornhill (Saunders, Lewis, & Thornhill, 2009). Research Onion helps to reach an effective methodology by exploring each layer in it as shown in Figure 3.1 below. The research methodology begins with the definition of the main philosophy, followed by the selection of approaches, methods, and strategies, as well as the establishment of time horizons, all of which led to the research design - the main techniques and procedures for data collection and analysis (Melnikovas, 2018).

Diagram, venn diagram

Description automatically generated

Figure 3.1: Research Onion (Saunders, Lewis, & Thornhill, 2009)

**3.2 RESEARCH PHILOSOPHY**

Research philosophy can be thought of as your assumptions about how you look at the world. These assumptions pave the path for the selection of methods and research strategies (Saunders, Lewis, & Thornhill, 2009).

In this research, the pragmatic philosophy will be adopted for the Barcode scanner and E-payment to develop a model to act as the best option to meet the objectives and deal with the research problem. In addition, according to (Kelemen & Rumens, 2008), pragmatism concepts are only relevant when they support action. Which aligns exactly with this study and need. It also includes the integration of different perspectives to understand the required data (Saunders, Lewis, & Thornhill, 2009).

Whereas the User Interface part of the mobile application fits with the Interpretivist philosophy, due to the design and evaluation of the front end being subjective in nature. Being subjective in nature may need change, socially constructive, and focus on the details of the various scenario involved considering the reality of those details (Saunders, Lewis, & Thornhill, 2009).

The crucial part of this study is to make sure to minimize the subjective components involved in the UI design to meet the Pragmatist philosophy.

**3.3 RESEARCH APPROACH**

The research Approach provides a plan and procedure to adopt the Data Collection and Analysis (Saunders, Lewis, & Thornhill, 2009).

The **Abductive** approach is suitable for this research as it modifies the existing theory to develop a new model. That is, it uses the already existing Barcode Scanning and E-payment technology to develop a new model incorporating both technologies. Furthermore, in nature, abduction can support the between data and theory in both directions rather than theory to data (Deductive) and data to theory (Inductive) (Suddaby, 2006). A major part of the proposal covers Barcode Scanning, E-payment, and UI design. These sections require evaluation independently as well as after the integration also.

**3.4 METHODOLOGICAL CHOICE**

The methodological choice addresses research methodology, research strategy, and time horizon selection in this study. All these sections are correlated with each other.

1. **RESEARCH METHODOLOGY**

As discussed in the research approach, abductive nature is adopted in this study. The main features involved are Barcode scanning, E-Payment, and UI design. They use the mixed method design for data collection and data analysis as discussed below.

Mixed multi-method facilitates the discovery of new insights and the qualitative method helped in explaining the relationship between variables discovered by the quantitative method, which is not possible with adapting the single/mono methods. Also, with mixed methods, the conclusions are attained with greater confidence since the method used may have an impact on the findings. The use of a single method will make determining the nature of that effect impossible (Saunders, Lewis, & Thornhill, 2009).

**Barcode Scanning and E-Payment**

In this proposal, the mobile camera act as the barcode scanner. The barcode scanner reads the Barcode of the product and processes the digits to identify it. Thus, the quantitative data are handled for scanning, accuracy, and processing time.

E-payments deal with the total amount to be paid, credit/debit card number, and processing time for the transaction. Therefore, the quantitative data are evaluated.

**UI Design**

The user interface handles the mixed method, as it involves the evaluation based on user credentials, performance, and customization. That makes the use of both quantitative and Qualitative data.

**PRIMARY RESEARCH**

In this study, Questionnaires are used to collect and analyse the feedback data obtained to evaluate the mobile application being developed. (Babbie, 1990) defined a Questionnaire as “a document containing questions and other types of items designed to solicit information appropriate to the analysis”. As the methodological choice is the Mixed multi-method for this study, the Questionnaire is apt as it supports both Quantitative and Qualitative data collection.

The Feedback Data is obtained from the Customer’s perspective, the Retailer’s/Employee’s in a shop, and the technical people’s perspective. For the customer’s feedback, anyone who is actively involved with retail shopping & who is using the existing self-checkout kiosk / traditional cashier checkout is approached. The small Retailers who find it difficult to include the self-checkout kiosk due to the space limitation or not being able to spend a lot on technology are approached to get feedback. And with the technical people, the ones who already have experience in testing the mobile application are approached from technical perspective. All the participants are involved voluntarily with their consent as attached in the appendix. Refer Participant Consent Form.

For Customers, the questions are framed to collect data about how satisfied they are with using this mobile application for shopping, which is evaluated quantitatively, and a provision is given to customers to give feedback in their own words, and those are evaluated qualitatively. Similarly, both qualitative and Quantitative data are collected from Retailers as well detailing whether this app supported the improvement of overall customer experience during shopping with eliminating time wastage. Different patterns are involved in scaling and collecting the data for feedback, Refer to the attachment in Appendix.

Even though the questionnaire supports the data collection for this study effectively, it holds various disadvantages generally. With the questionnaire, the researcher cannot confirm whether it is filled by the meant respondent, also it is difficult to clarify the questions if the respondent has any and only limited flexibility is available for the respondent to express their own perspective (Marshall, 2005). The questionnaire will be created in the Google Form to collect the data through online. In order to collect the data from people irrespective of their location, an online google form is used. The .apk file will be shared along with the sample barcodes to check the mobile application functionalities. Microsoft Excel is used as an analytical tool to analyse the data collected from the survey.

1. **RESEARCH STRATEGY**

Research Strategy is the plan of action to be carried out to achieve the goal, that is how to answer the research question. It serves as a methodological link between research philosophy and data collection and analysis methods (Denzin & Lincoln, 2011).

This study used a variety of research approaches and methodologies. This method combines both the Survey research strategy and the experimental research strategy. The research begins with a thorough examination of the prior literature, which includes previous studies and methods. With an Experimental research strategy, the time spent on a till in a retail shop can be determined using the implementation of this mobile application where payment is possible with online credit/ Debit card payment. In this scenario, the Independent Variable will be purchasing through the mobile application and performing Online Payments and the dependent variable will be the time taken to complete the shopping (or can say the time spent on bill counters/ till is reduced/avoided).

In order to evaluate the performance and outcome of the deliverable, a survey strategy is used through the method of a Questionnaire to collect the data.

1. **RESEARCH TIME HORIZON**

The Time Horizon is the time frame that is expected to be followed in order for the project to be finished (Saunders, Lewis, & Thornhill, 2009). With the two available time horizons, such as Cross-sectional and Longitudinal, according to (Rindfleisch, Malter, Ganesan, & Moorman, 2008) the Longitudinal time horizon covers the data collected over a time period for the same subject/product. A cross-sectional time horizon gathers the data at once at a particular time only. Thus, the cross-sectional time horizon matches this research since the outcome of the research is evaluated at a point in time like a snapshot due to its time constraint. The deliverable is evaluated with the participants during the research itself.

**3.5 TOOLS AND TECHNIQUES**

**3.5.1 PROJECT MANAGEMENT METHODOLOGY – AGILE METHODOLOGY**

This project will follow the AGILE methodology to develop a Mobile Application due to various reasons. Lee & Xia (2010) defined software development agility “as the software team’s capability to efficiently and effectively respond to and incorporate user requirement changes during the project life cycle”. Similarly, (Williams, 2010) described the agile methodology as a division of the Evolutionary as well as Iterative methods, in which each iteration holds the various phase involved in the software development life cycle such as Requirement Analysis, Design, Implementation, and Testing. Additionally, agile approaches have been demonstrated to offer higher productivity, better feedback, lower complexity, and fewer risk. As the Agile Methodology is flexible enough to incur changes during any project development phase (Ribeiro & Domingues, 2018). The modern mobile application environment necessitates lighter software development approaches that are also quicker and more agile (Abrahamsson, 2004). Above all, Continuous Integration paved a path for improving the quality of changes by addressing the integration problems and delivering the same (Mikael Lindvall, 2004).

Diagram

Description automatically generated

Figure 3.2: Phases involved in the Agile methodology software development lifecycle

(Source: derived from (Sharma, Sarkar, & Gupta, 2012))

**3.5.2 MOBILE APPLICATION REQUIREMENT ANALYSIS**

**3.5.2.1 FUNCTIONAL REQUIREMENT**

The functional requirements consist of all the functionalities that need to be involved in the mobile application such as,

1. User Registration New users should be able to register in the application to start using the application.
2. Credential Verification When the Login operation is performed, the username and password are verified to ensure the authenticity of the user.
3. User Login: Registered Users can log in to the application and start shopping.
4. Barcode Scanner option to start scanning the products selected.
5. Scanned products should be added to the Shopping cart.
6. Updating shopping cart – To Edit / Delete the products added to the cart before the payment.
7. Order Summary
8. Gateway Payment – Option to pay online through credit / Debit card.

**3.5.2.2 USER INTERFACE**

The user interface developed should be user-friendly, easy to access all the functionalities available, concise, and responsive. Also, it should be adaptable to different screen sizes. Overall, the mobile application should be user-centric.

**3.5.2.3 NON-FUNCTIONAL REQUIREMENTS**

• Scalability

• Performance

• Security

• Accessibility

• Usability

**3.5.2.4 SOFTWARE AND HARDWARE REQUIREMENTS**

**SOFTWARE REQUIREMENTS**

• Operating System : Microsoft Windows 7/8/10 (32-bit or 64-bit)

• Programming Language : Kotlin Java

• IDE/Workbench : Android Studio

• Database : Firebase

**HARDWARE REQUIREMENTS**

• Processor : Intel Core i5 or above

• Hard Disk : 256 GB or above

• RAM : 8GB RAM

1. **KOTLIN**

Initially, the Programming Language Java was considered for developing this mobile application for the reason of being familiar with it. With later research, Kotlin proves to be one of the apt programming languages for Android Development. Kotlin is a Java Virtual Machine based Language and an evolutionary feature of Java, which is also interoperable with Java, that is Kotlin enables Java to Kotlin and vice versa conversion (Flauzino et al., 2018).

Kotlin is a pragmatic programming language that is compatible with Android and the Java virtual machine. It integrates object-oriented and functional aspects (Góis Mateus & Martinez, 2019). Kotlin can infer the type of variable declarations, getters, equals, and hash code produced by the compiler since it understands the code (Flauzino et al., 2018). Moreover, Kotlin holds clear syntax, is less verbose, and it is little to no boilerplate code (Martinez & Gois Mateus, 2021). Kotlin's syntax is focused on eliminating verbosity; rough estimates show a 40% reduction in the number of LOC (Flauzino et al., 2018)

1. **ZXing Library**

For the barcode scanner, the ZXing library is used. There are various libraries available for barcode scanning in mobile applications, but ZXing is extremely integrated into the mobile application which makes it an easy option for any software developer to use. Also, it is open source (Milovidov, 2020). Various formats of barcodes can be read with this tool. Overall, it acts as a recommended option for Barcode scanning in the mobile application (Milovidov, 2020).

1. **PayPal Testing API**

The PayPal Testing API is integrated into the mobile application development for the payment part. Being nonfunded research, this API is used only for testing purposes.

1. **SOFTWARE DEVELOPMENT KIT**

Android Studio supports the complete development of Android Applications with Kotlin Code and incorporates debugging, refactoring, autocomplete, debugging, and lint check features. The developer can develop the application from scratch, and it also supports the conversion of java code to Kotlin (Góis Mateus & Martinez, 2019).

1. **FIREBASE**

Firebase is a framework for developing portable and web applications for businesses that require real-time database access. When it comes to mobile application development, Firebase manages the majority of the server-side work (Alsalemi et al., 2017). The following services are available with the Firebase,

**Real-Time Database:**

It is a Cloud-hosted Database. When developing a cross-platform application with the iOS, Android, and JavaScript SDKs, most of the user demand is based on a single Real-time database instance, which is updated with each new data, enabling the developer to skip over the database development and Firebase handles almost all the backend for the application (Alsalemi et al., 2017). The Firebase real-time database feature is simple to use. Once the Firebase and database dependencies are added to the application, unstructured data can be stored in the database (Khawas & Shah, 2018).

**Authentication:**

Firebase includes a user management system through which developers can enable user authentication via email and password login stored in Firebase (Khawas & Shah, 2018).

**Storage:**

Google Storage backs Firebase, a low-cost object storage service (Khawas & Shah, 2018). With Firebase Storage, various user-generated content such as photos, files, text, etc can be stored (Alsalemi et al., 2017). It enables easy and secure file transfer for Firebase apps regardless of network quality (Khawas & Shah, 2018). Since Firebase supports unstructured data structure, the database design covers only the required tables (known as Collections). The combination of related data is treated as a document and each document contains multiple fields (as same as columns in a relational database).

**3.5.2.5 Application Development Architecture**

Model View View Model (MVVM) is used for the Application development Architecture. It is the industry-recognized software architecture pattern that overcomes the drawbacks of traditional design patterns such as Model-View-Controller (MVC) and Model-View-Presenter (MVP). The MVVM separates the UI/View part from the business logic part.

It consists of three layers,

Model: This layer does the abstraction of the data sources

View: It informs the ViewModel layer about the user's action.

ViewModel: This layer acts as a link between Model and View.



Figure 3.3: Model View ViewModel Architecture

ViewModel and Model layer work together to retrieve and save the data.

There are two ways to implement the MVVM, through the Data Binding library by google and RxJava. The Data Binding is used for SMART SHOP, which enables the developer to bind the UI components with the application's data repository. Refer to the appendix for the build.gradle(.app) file.

**6 RESEARCH ETHICS**

The research methods are carried forward with the ethical practice put forward by The University [Research Ethics Policy](https://www.shu.ac.uk/research/excellence). The completed Ethics Checklist is attached in Appendix A.

**CHAPTER 4**

**4.1 MODEL IMPLEMENTATION**

With the tools and techniques and methodology already discussed in the research design chapter, the SMART SHOP mobile application is implemented. This chapter covers the details of the mobile application after its implementation including screenshots of it.

**4.1.1 Application Development Architecture**

As already mentioned, the Model-View-View Model(MVVM) Architectural pattern used for designing the application being one of the most recommended for android mobile application development.

Text

Description automatically generated

Figure 4.1 : Application Development architecture of SMART SHOP Mobile application

**4.1.2 USER INTERFACES**

**Splash Screen / Loading screen**

When the user opens the mobile application, the initial screen which is displayed to the user with the mobile application Logo is the splash screen. Refer Figure below

Graphical user interface, application

Description automatically generated

Figure 4.2: Splash screen

**Welcome Screen**

After the Splash screen, the welcome screen is displayed which gives an option for the user to Sign in or Register, if already created an account or to create a new account respectively. Refer figure below

Graphical user interface, text, application, chat or text message

Description automatically generated

Figure 4.3 Welcome Screen

**Register Screen**

With clicking the create account button on the welcome screen, the Register screen is displayed. The user can create a new account by filling in the fields First name, Last name, Email ID, and password. All the fields are required, and the email ID should be unique. Refer to the figure below. With the successful registration, the welcome screen is displayed again so that users can sign in to start shopping (refer to figure)

**Graphical user interface, application

Description automatically generated**

Figure 4.4: Register screen

**Sign In screen**

For an already created account, the user can directly sign in from the welcome screen. With a valid email and password, the user can log in to the mobile application. Refer to figure

**Graphical user interface, application, website

Description automatically generated**

Figure 4.5: Sign In screen

**Welcome screen for Logged in Customers**

This welcome screen will be displayed when the customer signs in with valid credentials. Various options available are continue shopping, logout along with the user profile as shown in figure below

Graphical user interface, application

Description automatically generated

Figure 4.6: Welcome screen for logged in customers

**Shopping Cart**

The shopping cart screen is displayed by clicking the Continue Shopping option on the welcome screen. The floating barcode scanning button along with the proceed to payment button is displayed on the screen. Initially Proceed to payment button will be disabled as there are no products added to the cart.

Graphical user interface, application

Description automatically generated

Figure 4.7: Shopping Cart – initial display

**After Adding items to the Shopping Cart**

With the added items, the option to delete, or update the quantity is displayed along with the product name. Also, the total amount of the cart items are displayed, and Proceed to Payment button is enabled to proceed further.

Graphical user interface, application

Description automatically generated

Figure 4.8: Shopping Cart items

**Barcode Scanner Screen**

The screen is displayed by clicking the barcode option on the shopping cart screen. The camera is opened with a square focus to start scanning the barcode. The barcode needs to be scanned horizontally. Refer the figure

A picture containing text, electronics

Description automatically generated

Figure 4.9 Barcode Scanner Camera

**Order Summary**

The Order Summary screen is displayed by clicking the Proceed to payment button in Shopping Cart. It gives an overview of the number of items purchased, the amount to be paid, and an option to add a promo code. Refer figure

Graphical user interface, text, chat or text message

Description automatically generated

Figure 4.10 : Order Summary

**Payment screen**

With clicking the Confirm button in the Order summary screen, the Payment screen is displayed. This is a PayPal API integrated to test the payment scenario. Refer the figure

Graphical user interface, application

Description automatically generated

Figure 4.11 Banking payment login screen

Graphical user interface

Description automatically generated

Figure 4.12 Payment Confirmation screen with payment

**Payment Success screen**

With successful payment, this screen is displayed along with the success message to notify the customer regarding the payment. Refer the figure

A screenshot of a phone

Description automatically generated with low confidence

Figure 4.13 Payment Success screen

**Payment Failure screen**

If any error occurred with payment, this screen is displayed with the failure message to notify the customer regarding the payment status. Refer the figure

**Order History Screen**

The customer’s order history is displayed on this screen with the order ID as shown in the figure.

Graphical user interface, text, application

Description automatically generated

Figure 4.14 Order History screen

**CHAPTER 5**

**RESULTS**

To assess whether the SMART SHOP mobile application helps to reduce the overall time spent during shopping and lessen the human effort, feedback questions were framed to get the data from Customers who do the shopping, Retailers who run the shop, or Employees working in a shop and in order to evaluate the mobile application, technical people are involved in the survey. After the questions were framed and the survey is completed within the time frame, the collected data are linked together for analysis. The result of the primary research is collected through Google Forms, and they are analysed through the Excel tool – Pivot table function, to determine each survey question's response.

**Responses from Customer’s Questionnaire,**

It consists of 13 questions (Refer: To appendix), and around 27 respondents shared their feedback. Questions directly relevant to the hypothesis are shared below. For all the questions refer to Appendix. 12th question being optional to provide feedback many respondents skipped to answer the same.

Customer Feedback Survey Question 1

|  |  |  |  |
| --- | --- | --- | --- |
| 1. What is your age group? | | | |
| 18-28 | 28-38 | 38-48 | Above 48 |
| 14 | 12 | 1 | 0 |

Table 5.1

Customer Feedback Survey Question 2

|  |  |  |  |
| --- | --- | --- | --- |
| 2. What gender do you identify as? | | | |
| Female | Male | Prefer not to say | Non-binary |
| 10 | 16 | 1 | 0 |

Table 5.2

Customer Feedback Survey Question 3

|  |  |
| --- | --- |
| 3. Where do you live? | |
| 112 Woodbury road, S91NZ, Sheffield | 1 |
| India | 3 |
| India | 2 |
| Karur, Tamil Nadu, India. | 1 |
| Kerala | 1 |
| London | 1 |
| London | 1 |
| Manchester | 1 |
| Manchester | 1 |
| Namakkal | 1 |
| Sheffield | 5 |
| Sheffield | 3 |
| Sheffield United Kingdom | 1 |
| Slough | 2 |
| Tamilnadu | 1 |
| United Kingdom | 2 |

Table 5.3

From Table 5.3, it can be generalized into two countries, such as India and the United Kingdom.

For India – 9,

United Kingdom - 18

Customer Feedback Survey Question 4

|  |  |  |
| --- | --- | --- |
| 4. How frequently you do in-store shopping? | | |
| Daily | Multiple times in a week | Weekly once |
| 1 | 10 | 16 |

Table 5.4

Customer Feedback Survey Question 5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5. How satisfied you are with the SMART SHOP mobile application based on the time spent in a shop / in the till | | | | |
| Highly satisfied | Neither satisfied Nor Dissatisfied | Satisfied | Dissatisfied | Highly Dissatisfied |
| 7 | 1 | 19 | 0 | 27 |

Table 5.5

Customer Feedback Survey Question 6

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 6. How far are you satisfied with the online payment modes available through the SMART SHOP mobile application? | | | | |
| Dissatisfied | Highly satisfied | Neither satisfied Nor Dissatisfied | Satisfied | Highly Dissatisfied |
| 1 | 6 | 2 | 18 | 0 |

Table 5.6

Customer Feedback Survey Question 7

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 7. How satisfied you are with the usability/user friendliness of the SMART SHOP mobile application? | | | | |
| Highly satisfied | Neither satisfied Nor Dissatisfied | Satisfied | Dissatisfied | Highly Dissatisfied |
| 13 | 1 | 13 | 0 | 0 |

Table 5.7

Customer Feedback Survey Question 8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 8. Which features didn’t work as expected? | | | | |
| Adding product to shopping cart | Login / Register | None | Online Payment | Scanning the products |
| 3 | 1 | 16 | 6 | 1 |

Table 5.8

Customer Feedback Survey Question 9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 9. On a scale of 1 to 5, rate your experience using the mobile application. (Out of 5, 1 being the lowest and 5 being the highest) | | | | |
| 1 | 2 | 3 | 4 | 5 |
| 0 | 0 | 6 | 52 | 60 |

Table 5.9

Customer Feedback Survey Question 10

|  |  |  |
| --- | --- | --- |
| 10. How often can do you consider to use SMART SHOP mobile application in the shopping process? | | |
| Never | Often | sometimes |
| 1 | 18 | 8 |

Table 5.10

Customer Feedback Survey Question 11

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11. Based on your shopping with this SMART SHOP mobile application, how likely do you recommend this mobile application to friends and family? (Out of 5, 1 being the lowest and 5 being the highest) | | | | |
| 1 | 2 | 3 | 4 | 5 |
| 0 | 0 | 3 | 13 | 13 |

Table 5.11

Customer Feedback Survey Question 12

|  |
| --- |
| 12. If any feature needs to be added or improved, what should be added? Provide your valuable feedback |
| An option to report if a product is not available in the store |
| App exceeds my expectations and it's user friendly. |
| Customer feedback in detail |
| It's good |
| Na |
| None |
| Nothing to be added |
| Overall is good |

Table 5.12

Customer Feedback Survey Question 13

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 13. Which checkout system do you often use while shopping currently? | | | | |
| Amazon Go | Barcode scanner hand held device | Self checkout | Traditional Checkout in lane | Others |
| 1 | 5 | 14 | 7 | 0 |

Table 5.13

**Responses from Retailer’s/Employees in shop - Questionnaire,**

It consists of 9 questions (Refer: Appendix ), and around 22 respondents shared their feedback. Questions directly relevant to the hypothesis are shared below. For all the questions refer to Appendix . 8th question being optional to provide feedback many respondents skipped to answer the same.

Retailer/Employee Feedback Survey Question 1

|  |  |  |  |
| --- | --- | --- | --- |
| 1. what is your age group? | | | |
| 18-28 | 28-38 | 38-48 | Above 48 |
| 12 | 10 | 0 | 0 |

Table 5.14

Retailer/Employee Feedback Survey Question 2

|  |  |
| --- | --- |
| 2. which city do you live in? | Count |
| Attur | 1 |
| Bangalore | 1 |
| Chennai | 3 |
| Chennai | 1 |
| Coimbatore | 2 |
| Coimbatore | 3 |
| Coimbatore ,India | 1 |
| Coimbatore,India | 1 |
| Delhi | 1 |
| Galway | 1 |
| India | 1 |
| India | 1 |
| India - Bangalore | 1 |
| PALAKKAD | 1 |
| Palakkad- Kerala | 1 |
| Sheffield | 1 |
| Thirupur Tamil Nadu India | 1 |

Table 5.15

Retailer/Employee Feedback Survey Question 3

|  |  |  |  |
| --- | --- | --- | --- |
| 3. How long do you run / work in this shop? | | | |
| 1-3 year | 4-7 year | less than a year | More than 7 years |
| 8 | 2 | 12 | 0 |

Table 5.16

Retailer/Employee Feedback Survey Question 4

|  |  |  |
| --- | --- | --- |
| 4. How far do you think the SMART SHOP mobile application improved the customer experience in shopping? | | |
| Highly Improved | Improved | Not Improved |
| 15 | 7 | 0 |

Table 5.17

Retailer/Employee Feedback Survey Question 5

|  |  |  |
| --- | --- | --- |
| 5. How likely does the SMART SHOP mobile application contributed to the improvement of service to the customer? | | |
| Likely | Most likely | Never |
| 3 | 19 | 0 |

Table 5.18

Retailer/Employee Feedback Survey Question 6

|  |  |  |
| --- | --- | --- |
| 6. How far has the SMART SHOP mobile application improved the work of staff in the shop? | | |
| Highly Improved | Improved | Not improved |
| 19 | 3 | 0 |

Table 5.19

Retailer/Employee Feedback Survey Question 7

|  |  |  |
| --- | --- | --- |
| 7. According to your opinion, do you consider adopting to SMART SHOP mobile application in the future? | | |
| likely | Most likely | Never |
| 4 | 18 | 0 |

Table 5.20

Retailer/Employee Feedback Survey Question 8

|  |
| --- |
| 8. If any feature needs to be added or improved, what should be added? / Provide your valuable feedback |
| All are good |
| Application is easy-to-use. It makes the whole process comfortable. |
| Highly satisfied |
| It should be introduced in larger scale and awareness among the public is needed. |
| Keep going!!!! |
| Keep going.. You're doing a great job |
| Nil |
| Nothing |
| This application can be even more developed with More options in future |
| This application can be further developed with more options. |

Table 5.21

Retailer/Employee Feedback Survey Question 9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 9. Which checkout system is currently used in your shop? | | | | |
| Amazon Go | Barcode scanner hand held device | Self checkout | Traditional Checkout in lane | Others |
| 0 | 2 | 0 | 20 | 0 |

Table 5.22

**Responses from Technical People - Questionnaire,**

It consists of 10 questions (Refer: Appendix ), and around 12 respondents shared their feedback. Questions directly relevant to the hypothesis are shared below. For all the questions refer to Appendix

Technical Feedback Survey Question 1

|  |  |  |
| --- | --- | --- |
| 1. Rate the User Interface of the SMART SHOP mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.23

Technical Feedback Survey Question 2

|  |  |  |
| --- | --- | --- |
| 2. Rate the compatibility of the screen dimension in various mobile screen sizes | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.24

Technical Feedback Survey Question 3

|  |  |  |
| --- | --- | --- |
| 3. Rate the accessibility of the mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.25

Technical Feedback Survey Question 4

|  |  |  |
| --- | --- | --- |
| 4. Rate the data fetch in each functionality involved. | | |
| Good | Need Improvement | Bad |
| 11 | 1 | 0 |

Table 5.26

Technical Feedback Survey Question 5

|  |  |  |
| --- | --- | --- |
| 5. Rate the barcode scanning functionality in the mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.27

Technical Feedback Survey Question 6

|  |  |  |
| --- | --- | --- |
| 6. Rate the Add product to the cart functionality in the mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.28

Technical Feedback Survey Question 7

|  |  |  |
| --- | --- | --- |
| 7. Rate the Deleting functionality in the mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.29

Technical Feedback Survey Question 8

|  |  |  |
| --- | --- | --- |
| 8. Rate the updating quantity in the cart functionality in the mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.30

Technical Feedback Survey Question 9

|  |  |  |
| --- | --- | --- |
| 9. Rate the Purchase History functionality in the mobile application | | |
| Good | Need Improvement | Bad |
| 12 | 0 | 0 |

Table 5.31

Technical Feedback Survey Question 10

|  |  |
| --- | --- |
| 10. If any feature needs to be added or improved, what should be added? | Count |
| All good | 1 |
| No need to improve any thing, all are good now itself | 1 |
| None | 1 |
| Passwords can be tested against its strength and security | 1 |
| (blank) | 8 |

Table 5.32

**CHAPTER 6**

**DISCUSSION**

The aim of the research is to reduce human effort and time spent in the retail shop through the help of the SMART SHOP mobile application for self-checkout. The data are collected from the users to identify their overall satisfaction and the adoption rate. As mentioned earlier, the data are collected from the Customer’s perspective, the Retailer/ Employee’s perspective, and technical people to evaluate the Usability and functionality of the mobile application. From the survey analysis result conducted, the major findings, and key points are listed below,

* Majority of the customers are satisfied with the SMART SHOP mobile application in the case of reducing the time spent on the retail shop
* Majority of the customers find it easy to use the mobile application.
* The online payment does not meet the user’s expectation
* Majority of the Retailers/Employees are satisfied with the mobile application
* Employees/Retailers believe that the application improvised the shopping experience.
* Customers following the traditional checkout and self-checkout kiosks are much more satisfied with the SMART SHOP mobile application.
* Relationships exist between the existing system the customers are using and their satisfaction rate.
* The technical evaluation of the mobile application is good.

The study demonstrates a relationship between the current system being used by the customers and satisfaction with this approach. Customers who have access to or are using the Traditional Checkout Lane find this solution Highly Satisfied with concern about the time spent during shopping.

**PASTE THE BAR CHART WITH THE CURRENT SYSTEM USED BY CUSTOMERS AND THEIR SATISFACTION**

Table 5.4 indicates that the research result is in line with the hypothesis, where most of the customers (around 96.13%) find the application as Satisfied (Refer to Appendix). The rest of the population summarizes that there is no improvement in shopping with the mobile application. It was expected that the people who do shopping often, will find this application more useful. But according to the results obtained, it is predicted that there is no relationship between the frequency of shopping and satisfaction. Also, it was expected that Retailers / Employees would suggest more options and features be added, but there was no specific mention of those. As expected, the online payment was noted as a feature that does not work as expected. As mentioned earlier in Research design, being non-funded research, the testing API of PayPal from the open source is integrated into it. For any other payments including the UPI, Banking is not possible as of now. Even though the response to various questions varied according to each customer, they are overall satisfied and also feel good to recommend this mobile application to family and friends. That is, it is quite difficult to predict the sentiment toward this approach from these patterns of results.

No particular pattern exists with the results obtained from the retailer’s/Employees’ perspective. Almost all the respondents accepted the SMART SHOP application irrespective of the years they are working(running) in the shop and the existing system they are following for the checkout. It was expected that the retailer/Employee who has access to Self-checkout may suggest further options, but none was mentioned. It is also predicted that the impact of the majority of the retailers/Employees using the traditional checkout influenced the positive approach towards this application.

As mentioned for customers, retailers/employees find the application overall useful, Table 5.16 and 5.16 concludes that the overall customer experience and service provided to the customers are highly improved with the SMART SHOP mobile application.

**IMPLICATIONS**

As discussed in the Literature review, the study by (Johnson, Kiser, Washington, & Torres, 2018) and (Arvidsson, 2014) indicated the relative advantages of adopting the mobile self-checkout service agreed with the results obtained through the survey. As mentioned earlier Relative advantage is the degree to which an innovation is perceived to be superior to its predecessor. This research suggests that the adoption rate of SMART SHOP mobile applications from both Customer and Retailer perspectives is high. Likewise, Compatibility is defined by (Moore & Benbasat, 1991) as the extent to which an innovation is perceived to be consistent with an individual's values, needs, and prior experience. From the research, it is evident that the existing experience of shopping/checkout impacted their overall approach and satisfaction towards this mobile application.

Another study by (Giesen, 2012), stated that people under the age of 45 prefer to avail the self-services available in a retail shop, the SMART SHOP mobile application also matches along with this hypothesis, but is not able to predict the behaviour of people above the age of 45, there is no respondent above the age of 45 answered to the survey.

Moreover, customer satisfaction and their adoption level are also addressed through these research findings, which contribute to the already existing literature on self-service technology or say self-checkout.

**LIMITATIONS OF THE RESEARCH**

Throughout the research, various limitations are addressed, they are listed below,

* Being non-funded research and due to the time constraints, basic functionalities required for the exact research with positive scenario only are developed in the deliverable mobile application.
* The deliverable Mobile application cannot be directly used for commercial purposes.
* In the survey, the majority of the respondents are below 38, thus the adoption rate predicted may vary in the real world, it can be considered only for the initial study.
* Since a Questionnaire is used for the survey, it is not evident whether the respondents have genuinely provided their feedback.
* With this mobile application, It is not possible to completely remove the existing checkout system since it is completely dependent on the help of the Internet for accessing the real-time data for all the functionalities required.

**Future Direction**

* The mobile application needs to be developed in the iOS platform with including the following functionalities.
* The mobile application to help the users to find the location of the products in the store with the help of embedding Augmented reality into the camera, thereby enhancing the customer experience.
* Theft Management System needs to be implemented to avoid robbery and unintentionally missing to scan the items while adding to the physical cart.
* A provision to search for in-stock products and provide reviews for the products purchased can help the customers to enhance their shopping experience.
* Support system/Help system to reach the shop assistant can be integrated to get any other help that needs to be done physically. For example, the specially abled can get assistance to help with loading the products, carrying them to their vehicle, etc.
* Loyalty card system can be integrated to assign reward points on each purchase, and applicable coupons and discounts on the next purchase can be listed.
* Wish List can be added so that customers can add the products for reminding while doing in-store shopping.
* With each purchase, the stock inventory can be updated in the store’s database, which can help with Inventory management.
* With Analysing the Shopping patterns of each customer, the product suggestion can be implemented which provides insight into customization.

**CHAPTER 6**

**CONCLUSION**

A Self-checkout Mobile application named SMART SHOP is developed, and it is tested for acceptance and usage through a survey, as well the functionalities through test cases. The main objective of the SMART SHOP mobile application was to introduce self-assistance and self-checkout to customers in supermarkets or any retail shop to enable faster checkout. It ultimately offers customers a unique in-store shopping experience.

The central questions for this research were as follows:

* How to reduce human effort and time during shopping in a retail shop?

The research result was obtained through both quantitative and qualitative data from the participants (Users, Retailers/Employees, and technical people). The data are collected from 27 Customers who do shopping, 22 retailers running the shop or Employees working in the shop, and 12 Technical people to evaluate the application. The result illustrates a positive approach, acceptance, and satisfaction towards this application. The adoption rate from all groups of participants was welcoming.

The SMART SHOP mobile application mainly includes the Functionalities Login for the User, Registration to use the application, Scanning the Products to add to the Shopping Cart, Payment functionality, and Order History. The Methodology/tools and techniques used to develop are the widely included options. For Front End, being an Android Mobile application Android is used and Android Studio is chosen as Software Development Kit. The Back End is carried forward with the Firebase Realtime Database.

As our research shows, self-checkout applications are enabling retailers to not only provide self-checkout functionality but also provide value-added services that enable retailers to pursue new digital business models and information system-based services that can be provided to consumers.

Customers benefit from the faster checkout and convenient shopping experience whereas, Retailers can differentiate themselves from the crowded market.

While the absence of respondents above the age of 38 restricts the generalizability of the study, the study provides a new insight into the fact that people below the age of 38 have not shown hesitation to adopt mobile self-checkout.

The research clearly illustrates the usability and adaptability of the mobile self-checkout, but it also raises a question of whether it can completely replace the already existing checkout system as this mobile application is completely working based on internet connectivity and the alternative option also need to be considered. from the Retailer’s perspective to completely accept this technology.

It is predicted from the research that the existing system used for checkout has an impact on the research results. People who are using the traditional checkout currently find the application a technological advancement and they are ready to adopt this new process.

To better understand the implications of this research, future studies could include engaging the survey with more participants and collecting additional data over a longer period of time by testing these on a real-world shopping environment, which can give more insight into the application adoption, and determining the sentimental factors with adjusting to the technology. Also, further research is needed to address the financial requirement comparison for implementing various types of self-checkout options including the Self check out kiosk, Barcode scanner handheld device, using Artificial Intelligence and Camera sensors like Amazon go. So that the Retailers can clearly understand the technology they can afford according to their needs.

**References**

Abrahamsson, P. (2004). Learning from agile software development. Paper presented at the 7. doi:10.1049/ic:20040438 Retrieved from <http://digital-library.theiet.org/content/conferences/10.1049/ic_20040438>

Agarwal, S., Khapra, M., Menezes, B., & Uchat, N. (2007). Security issues in mobile payment systems.*Computer Society of India,*, 142-152.

Ahmed, A., Abi Sen, S. A., Fallata, A. M., Almuashi, A. Y., Yassin, O. N. A., & Alrowaili, M. A. F. (2021). Barcode reader application to enhance the level of trust and safety of customers. Paper presented at the *2021 8th International Conference on Computing for Sustainable Global Development (INDIACom),*400-404.

Ahn, J. A., & Seo, S. (2018). Consumer responses to interactive restaurant self-service technology (IRSST): The role of gadget-loving propensity.*International Journal of Hospitality Management, 74*, 109-121.

Al-Jabri, I. M., & Sohail, M. S. (2012). Mobile banking adoption: Application of diffusion of innovation theory.*Journal of Electronic Commerce Research, 13*(4), 379-391.

Alsalemi, A., Al Homsi, Y., Al Disi, M., Ahmed, I., Bensaali, F., Amira, A., & Alinier, G. (2017). Real-time communication network using firebase cloud IoT platform for ECMO simulation. Paper presented at the *2017 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData),*178-182.

Andriulo, S., Elia, V., & Gnoni, M. G. (2015). Mobile self-checkout systems in the FMCG retail sector: A comparison analysis.*Int.J.RF Technol.Res.Appl., 6*(4), 207-224.

Arvidsson, N. (2014). Consumer attitudes on mobile payment services–results from a proof of concept test.*International Journal of Bank Marketing,*

Atkins, K. G., & Kim, Y. (2012). Smart shopping: Conceptualization and measurement.*International Journal of Retail & Distribution Management,*

Babbie, E. (1990). The logic of survey sampling. Paper presented at the *Survey Research Methods,*65-101.

Belibov, D., & Tudose, D. S. (2019). Smart shopping cart. Paper presented at the *2019 18th RoEduNet Conference: Networking in Education and Research (RoEduNet),*1-6.

Bitner, M. J. (1997). Services marketing: Perspectives on service excellence.*Journal of Retailing, 73*(1), 3-7.

Bitner, M. J., Ostrom, A. L., & Meuter, M. L. (2002). Implementing successful self-service technologies.*Academy of Management Perspectives, 16*(4), 96-108.

Boulding, W., Kalra, A., Staelin, R., & Zeithaml, V. A. (1993). A dynamic process model of service quality: From expectations to behavioral intentions.*Journal of Marketing Research, 30*(1), 7-27.

Caruana, A. (2002). Service loyalty: The effects of service quality and the mediating role of customer satisfaction.*European Journal of Marketing,*

Chang, H. H., & Wang, H. (2011). The moderating effect of customer perceived value on online shopping behaviour.*Online Information Review,*

Chen, L. (2008). A model of consumer acceptance of mobile payment.*International Journal of Mobile Communications, 6*(1), 32-52.

Cho, H., & Fiorito, S. S. (2010). Self-service technology in retailing. the case of retail kiosks.*Symphonya.Emerging Issues in Management,*(1), 43-55.

Curran, J. M., & Meuter, M. L. (2005). Self‐service technology adoption: Comparing three technologies.*Journal of Services Marketing,*

Curran, J. M., Meuter, M. L., & Surprenant, C. F. (2003). Intentions to use self-service technologies: A confluence of multiple attitudes.*Journal of Service Research, 5*(3), 209-224.

Dabholkar, P. A. (1994). Incorporating choice into an attitudinal framework: Analyzing models of mental comparison processes.*Journal of Consumer Research, 21*(1), 100-118.

Dabholkar, P. A., Bobbitt, L. M., & Lee, E. (2003). Understanding consumer motivation and behavior related to self‐scanning in retailing: Implications for strategy and research on technology‐based self‐service.*International Journal of Service Industry Management,*

Dabholkar, P. A., Shepherd, C. D., & Thorpe, D. I. (2000). A comprehensive framework for service quality: An investigation of critical conceptual and measurement issues through a longitudinal study.*Journal of Retailing, 76*(2), 139-173.

Dahlberg, T., Mallat, N., Ondrus, J., & Zmijewska, A. (2008). Past, present and future of mobile payments research: A literature review.*Electronic Commerce Research and Applications, 7*(2), 165-181.

De Leon, M. V., Atienza, R. P., & Susilo, D. (2020). Influence of self-service technology (SST) service quality dimensions as a second-order factor on perceived value and customer satisfaction in a mobile banking application.*Cogent Business & Management, 7*(1), 1794241.

Demirci Orel, F., & Kara, A. (2014). Supermarket self-checkout service quality, customer satisfaction, and loyalty: Empirical evidence from an emerging market.*Journal of Retailing and Consumer Services, 21*(2), 118-129. doi:10.1016/j.jretconser.2013.07.002

Denzin, N. K., & Lincoln, Y. S. (2011). *The sage handbook of qualitative research* sage.

Dingsøyr, T., Nerur, S., Balijepally, V., & Moe, N. B. (2012). A decade of agile methodologies: Towards explaining agile software development.*Journal of Systems and Software, 85*(6), 1213-1221. doi:10.1016/j.jss.2012.02.033

Djelassi, S., Diallo, M. F., & Zielke, S. (2018). How self-service technology experience evaluation affects waiting time and customer satisfaction? A moderated mediation model.*Decision Support Systems, 111*, 38-47.

Elliott, K. M., Meng, J., & Hall, M. C. (2008). Technology readiness and the likelihood to use self-service technology: Chinese vs. american consumers.*Marketing Management Journal, 18*(2), 20-31.

Fernandes, T., & Pedroso, R. (2017). The effect of self-checkout quality on customer satisfaction and repatronage in a retail context.*Service Business, 11*(1), 69-92.

Fitzsimmons, J. A. (2003). Is self‐service the future of services?*Managing Service Quality: An International Journal,*

Flauzino, M., Veríssimo, J., Terra, R., Cirilo, E., Durelli, V. H., & Durelli, R. S. (2018). Are you still smelling it? A comparative study between java and kotlin language. Paper presented at the *Proceedings of the VII Brazilian Symposium on Software Components, Architectures, and Reuse,*23-32.

Gerrard, P., & Cunningham, J. B. (2003). The diffusion of internet banking among singapore consumers.*International Journal of Bank Marketing,*

Góis Mateus, B., & Martinez, M. (2019). An empirical study on quality of android applications written in kotlin language.*Empirical Software Engineering, 24*(6), 3356-3393.

Guha, A. (2013). Spotlight on australia: Consumer payments revolution.*Insights from JP Morgan,*

Hirschman, E. C., & Holbrook, M. B. (1982). Hedonic consumption: Emerging concepts, methods and propositions.*Journal of Marketing, 46*(3), 92-101.

Hsieh, C. (2005). Implementing self-service technology to gain competitive advantages.*Communications of the IIMA, 5*(1), 9.

Jacoby, J., & Kyner, D. B. (1973). Brand loyalty vs. repeat purchasing behavior.*Journal of Marketing Research, 10*(1), 1-9.

Johnson, V. L., Kiser, A., Washington, R., & Torres, R. (2018). Limitations to the rapid adoption of M-payment services: Understanding the impact of privacy risk on M-payment services.*Computers in Human Behavior, 79*, 111-122.

Johnson, V. L., Woolridge, R. W., Wang, W., & Bell, J. R. (2020). The impact of perceived privacy, accuracy and security on the adoption of mobile self-checkout systems.*Journal of Innovation Economics Management,*(1), 221-247.

Jong, A. d., & De Ruyter, K. (2004). Adaptive versus proactive behavior in service recovery: The role of self‐managing teams.*Decision Sciences, 35*(3), 457-491.

Karnouskos, S. (2004). Mobile payment: A journey through existing procedures and standardization initiatives.*IEEE Communications Surveys & Tutorials, 6*(4), 44-66.

Kelemen, M. L., & Rumens, N. (2008). *An introduction to critical management research* Sage.

Kelly, P., Lawlor, J., & Mulvey, M. (2010). A review of key factors affecting consumers’ adoption and usage of self-service technologies in tourism. Paper presented at the *THRIC Conference, Shannon,*15-16.

Khawas, C., & Shah, P. (2018). Application of firebase in android app development-a study.*International Journal of Computer Applications, 179*(46), 49-53.

Kheng, L. L., Mahamad, O., & Ramayah, T. (2010). The impact of service quality on customer loyalty: A study of banks in penang, malaysia.*International Journal of Marketing Studies, 2*(2), 57.

Kim, C., Mirusmonov, M., & Lee, I. (2010). An empirical examination of factors influencing the intention to use mobile payment.*Computers in Human Behavior, 26*(3), 310-322.

Kotler, P., & Armstrong, G. (2010). *Principles of marketing* Pearson education.

Lee, G., & Xia, W. (2010). Toward agile: An integrated analysis of quantitative and qualitative field data on software development agility.*MIS Quarterly, 34*(1), 87-114. doi:10.2307/20721416

Lee, H. (2015). Consumer-to-store employee and consumer-to-self-service technology (SST) interactions in a retail setting.*International Journal of Retail & Distribution Management,*

Lee, H., Fairhurst, A. E., & Lee, M. (2009). The importance of self-service kiosks in developing consumers' retail patronage intentions.*Managing Service Quality, 19*(6), 687-701. doi:10.1108/09604520911005071

Leon, S. (2018). Service mobile apps: A millennial generation perspective.*Industrial Management & Data Systems,*

Li, R., Song, T., Capurso, N., Yu, J., Couture, J., & Cheng, X. (2017). IoT applications on secure smart shopping system.*IEEE Internet of Things Journal, 4*(6), 1945-1954.

Mallat, N. (2007). Exploring consumer adoption of mobile payments–A qualitative study.*The Journal of Strategic Information Systems, 16*(4), 413-432.

Mano, H., & Elliott, M. T. (1997). Smart shopping: The origins and consequences of price savings.*ACR North American Advances,*

Marshall, G. (2005). The purpose, design and administration of a questionnaire for data collection.*Radiography, 11*(2), 131-136.

Martinez, M., & Gois Mateus, B. (2021). Why did developers migrate android applications from java to kotlin?*IEEE Transactions on Software Engineering, 48*(11), 1. doi:10.1109/TSE.2021.3120367

Marzocchi, G. L., & Zammit, A. (2006). Self-scanning technologies in retail: Determinants of adoption.*The Service Industries Journal, 26*(6), 651-669.

McWilliams, A., Anitsal, I., & Anitsal, M. M. (2016). Customer versus employee perceptions: A review of self-service technology options as illustrated in self-checkouts in US retail industry.*Academy of Marketing Studies Journal, 20*(1), 79.

Melnikovas, A. (2018). Towards an explicit research methodology: Adapting research onion model for futures studies.*Journal of Futures Studies, 23*(2), 29-44.

Meuter, M. L., Bitner, M. J., Ostrom, A. L., & Brown, S. W. (2005). Choosing among alternative service delivery modes: An investigation of customer trial of self-service technologies.*Journal of Marketing, 69*(2), 61-83.

Meuter, M. L., Ostrom, A. L., Bitner, M. J., & Roundtree, R. (2003). The influence of technology anxiety on consumer use and experiences with self-service technologies.*Journal of Business Research, 56*(11), 899-906.

Mikael Lindvall, Dirk Muthig, Aldo Dagnino Christina Wallin, & Michael Stupperich. (2004). *Agile software development in large organizations*

Milovidov, Y. (2020). Analysis of existing solutions and methods for scanning barcode.*Ministry of Education and Science of Ukraine National Aviation University Software Engineering Department,*, 49.

Miwa, K., & Takakuwa, S. (2008). Simulation modeling and analysis for in-store merchandizing of retail stores with enhanced information technology. Paper presented at the *2008 Winter Simulation Conference,*1702-1710.

Moe, M. M., & Mon, S. S. Y. (2019). Automated billing system using smart shopping cart.*Electronics & Communication Engineering, 3*(4), 1669-1673.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation.*Information Systems Research, 2*(3), 192-222.

Morimura, F., & Nishioka, K. (2016). Waiting in exit-stage operations: Expectation for self-checkout systems and overall satisfaction.*Journal of Marketing Channels, 23*(4), 241-254.

Mukerjee, H. S., Deshmukh, G. K., & Prasad, U. D. (2019). Technology readiness and likelihood to use self-checkout services using smartphone in retail grocery stores: Empirical evidences from hyderabad, india.*Business Perspectives and Research, 7*(1), 1-15. doi:10.1177/2278533718800118

Nishitha, R., Naik, S. S., Raksha, V., & Kulsum, U. (2019). IoT based automatic billing system using barcode scanner by android device and monitoring unregistered barcode by RFID. Paper presented at the *2019 4th International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT),*15-20.

Ondrus, J., & Pigneur, Y. (2006). Towards a holistic analysis of mobile payments: A multiple perspectives approach.*Electronic Commerce Research and Applications, 5*(3), 246-257.

Orel, F. D., & Kara, A. (2014a). Supermarket self-checkout service quality, customer satisfaction, and loyalty: Empirical evidence from an emerging market.*Journal of Retailing and Consumer Services, 21*(2), 118-129.

Orel, F. D., & Kara, A. (2014b). Supermarket self-checkout service quality, customer satisfaction, and loyalty: Empirical evidence from an emerging market.*Journal of Retailing and Consumer Services, 21*(2), 118-129.

Pearson, S. (2016). *Building brands directly: Creating business value from customer relationships* Springer.

Raina, V. K. (2015). Overview of mobile payment: Technologies and security. *Banking, finance, and accounting: Concepts, methodologies, tools, and applications* (pp. 180-217) IGI Global.

Reichheld, F. F. (2001). Lead for loyalty.*Harvard Business Review, 79*(7), 76-84, 144.

Ribeiro, A., & Domingues, L. (2018). Acceptance of an agile methodology in the public sector.*Procedia Computer Science, 138*, 621-629. doi:10.1016/j.procs.2018.10.083

Rindfleisch, A., Malter, A. J., Ganesan, S., & Moorman, C. (2008). Cross-sectional versus longitudinal survey research: Concepts, findings, and guidelines.*Journal of Marketing Research, 45*(3), 261-279.

Rinta-Kahila, T., Penttinen, E., Kumar, A., & Janakiraman, R. (2021). Customer reactions to self-checkout discontinuance.*Journal of Retailing and Consumer Services, 61*, 102498.

Rowley, J., & Slack, F. (2003). Kiosks in retailing: The quiet revolution.*International Journal of Retail &amp; Distribution Management, 31*(6), 329-339. doi:10.1108/09590550310476060

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* Pearson education.

Schierz, P. G., Schilke, O., & Wirtz, B. W. (2010). Understanding consumer acceptance of mobile payment services: An empirical analysis.*Electronic Commerce Research and Applications, 9*(3), 209-216.

Schindler, R. M. (1998). Consequences of perceiving oneself as responsible for obtaining a discount: Evidence for smart-shopper feelings.*Journal of Consumer Psychology, 7*(4), 371-392.

Selnes, F., & Hansen, H. (2001). The potential hazard of self-service in developing customer loyalty.*Journal of Service Research, 4*(2), 79-90.

Shahid Iqbal, M., Ul Hassan, M., & Habibah, U. (2018). Impact of self-service technology (SST) service quality on customer loyalty and behavioral intention: The mediating role of customer satisfaction.*Cogent Business & Management, 5*(1), 1.

Sharma, S., Sarkar, D., & Gupta, D. (2012). Agile processes and methodologies: A conceptual study.*International Journal on Computer Science and Engineering, 4*(5), 892.

Stank, T. P., Goldsby, T. J., & Vickery, S. K. (1999). Effect of service supplier performance on satisfaction and loyalty of store managers in the fast food industry.*Journal of Operations Management, 17*(4), 429-447.

Suddaby, R. (2006). From the editors: What grounded theory is not.*Academy of Management Journal, 49*(4), 633-642.

Sureshchandar, G. S., Rajendran, C., & Anantharaman, R. N. (2002). The relationship between service quality and customer satisfaction–a factor specific approach.*Journal of Services Marketing,*

Swamy, T. R., Rao, S. S., Sharath, N., Gupta, P. H., & Rakesh, P.Smart shopping cart with app.

Williams, L. (2010). *Agile software development methodologies and practices* Elsevier. doi:10.1016/s0065-2458(10)80001-4

Wolfinbarger, M., & Gilly, M. C. (2003). eTailQ: Dimensionalizing, measuring and predicting etail quality.*Journal of Retailing, 79*(3), 183-198. doi:10.1016/S0022-4359(03)00034-4

Yang, S., Lu, Y., Gupta, S., Cao, Y., & Zhang, R. (2012). Mobile payment services adoption across time: An empirical study of the effects of behavioral beliefs, social influences, and personal traits.*Computers in Human Behavior, 28*(1), 129-142.

Yen, H. J. R., & Gwinner, K. P. (2003). Internet retail customer loyalty: The mediating role of relational benefits.*International Journal of Service Industry Management,*

Zeithaml, V. A., Berry, L. L., & Parasuraman, A. (1996). The behavioral consequences of service quality.*Journal of Marketing, 60*(2), 31-46.

Zhou, T. (2013). An empirical examination of continuance intention of mobile payment services.*Decision Support Systems, 54*(2), 1085-1091.