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Empowering Visually Impaired Consumers in Retail: A Systematic Review of Accessible Payment Solutions for All

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ABSTRACT

A decrease or loss of sensory ability may occur due to aging, accidents, illnesses, or congenital conditions. This underscores the critical importance of adopting an "inclusive approach to differences", as a principle that businesses must prioritize. This study aims to identify the dynamics of an accessible payment experience for visually impaired consumers (VICs) while shopping that can support consumer normalcy. By employing Synder's systematic literature review framework, the study examines the existing literature to assess the current state of payment systems used by VICs in retail with a dataset covering the period 2007-2024 drawn from Scopus, Web of Science, and Google Scholar, and synthesizes the stakeholder actions influencing market regulations and best practices. Key findings of the study highlight the payment tools employed by VICs in shopping, the challenges they face, and their coping mechanisms, and initiatives about accessible payment terminals, aimed at fostering a more inclusive payment experience to support consumer normalcy. With the study, by gathering the outputs of the literature, and practical insights from business operations and NGOs' efforts to reorganize regulations, it is intended to provide both theoretical contributions and actionable insights for practitioners and policy makers.

Keywords: Accessibility, Accessible Payment, Consumer Normalcy, Visually Impaired Consumer, Financial Inclusion.

JEL Classification Codes: M31, M14

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INTRODUCTION

A decrease in vision throughout the life cycle can occur because of some congenital disorders, various diseases, accidents, or age. In this context, aging, lifestyle factors or hereditary factors can often affect visual impairment (Swenor et al., 2019). The World Health Organization (WHO) reported that 2.2 billion people suffer from near or distance vision impairments, representing over 25% of the world's population struggling to navigate daily life with this challenge (WHO, 2023).

In Türkiye, the latest Health Survey findings demonstrate that 5.1% of the total population reports experiencing vision problems (TurkStat, 2023). The number of visually impaired individuals registered in the National Disability Data System of the Ministry of Health is 215,076 people (T.R. Ministry of Family and Social Services, 2023). Additionally, findings from the 2023 Turkey Elderly Profile Survey revealed that 10.1% of individuals aged 65 and above in the representative sample stated that they experienced great difficulty seeing or were unable to see at all. Women were found to experience these difficulties at higher rates than men did (TurkStat, 2024). Aging leads to a decline in vision. In this context, addressing the needs and expectations of a population with visual impairments or limitations in the marketplace while organizing business processes in alignment with inclusive production, marketing practices, and universal design principles can create reciprocal benefits for both consumers and businesses.

Inclusive design, defined as designing products to be "usable and accessible for everyone" from the outset without requiring significant adaptations, encourages businesses to embrace diversity and foster inclusivity and provides the opportunity to cater to the needs of a much wider spectrum of consumers (Cambridge University, 2017). However, when examining the overall market for goods and services, it is observed that, apart from niche products specifically developed to generate value for consumers with disabilities, the general target audience is predominantly assumed to be able-bodied consumers. This approach results in the launch of non-inclusive products to the market, which fail to address the needs of individuals with varying levels of ability in their design. This, in turn, can have a restrictive impact on the benefits derived from the goods/services or may even lead to their outright rejection. By adopting

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the "inclusive design - design for all" approach across processes ranging from product development to post-consumer use, it becomes possible to offer consumers more equitable, participatory, accessible, and inclusive goods and services that consider individual differences.

Inclusive design takes a broad approach to user needs, ensuring that products and services are accessible not only to able-bodied individuals but also to those with temporary or permanent impairments. This approach aligns with the Social Model of Disability, which argues that disability is a result of societal structures that exclude individuals based on their physical impairments (Oliver, 1996). In the Social Model of Disability, disability is defined as "the disadvantage or restriction of activity caused by a contemporary social organization that takes little or no account of people with physical impairments, thus excluding them from participation in the mainstream of social activities" (Oliver, 1996, p.22). By adopting inclusive design in retail, external barriers for participation in society can be removed and every individual can be treated equitably, regardless of any limitations they may face (Baker, 2006; Kaufman-Scarborough and Childers, 2009). Shoppers with disabilities, especially those with visual impairments, need more than just physical adjustments; they want to actively participate, be acknowledged, and feel a sense of belonging (Baker, 2006). Thus, this approach supports the concept of consumer normalcy, which reflects how individuals form and maintain their identities through shopping, striving to be accepted and recognized as equals in consumption contexts (Baker, 2006, Kaufman-Scarborough and Childers; 2009).

From this perspective, this research aims to analyze the literature by performing a systematic literature review and examining practices regarding payment systems that can enable consumers with visual impairments to experience consumer normalcy and support their autonomy while shopping in the retail environment. In addition, the focus is on actions taken by businesses in the market, the perspectives of macrolevel actors, and the evaluation of these dynamics. Specifically, this study seeks to answer the research question "How can an accessible payment experience be achieved for visually impaired consumers in retail to support consumer normalcy" by incorporating a systematic literature review, examples of good practices, and insights into the development of legal frameworks at the macro level worldwide. With the study, it is expected to shed light on practitioners and make theoretical contributions in this field.

CONCEPTUAL FRAMEWORK

Shopping, as an integral part of urban life, is defined as "a social movement, interaction, and experience that structures individuals' daily life practices" (Falk and Campbell, 1997). As one of the essential activities of daily living, it is imperative that the shopping experience for visually impaired individuals occurs within an environment that facilitates their ability to navigate autonomously and with greater independence. Equally important is their ability to experience the concept of "consumer normalcy," which can be succinctly defined as the desire "to be treated like everyone else" during shopping activities (Baker, 2006).

Baker's concept of consumer normalcy comprises four distinct dimensions: (1) "I belong"—the consumer's desire to cocreate a shopping experience with sellers and other customers, along with the aspiration to enjoy the value and pleasure offered by the market; (2) "This is me"—the wish to be recognized for their individuality, where differences are attributed not to visual impairments but to personal tastes and preferences; (3) "I'm in control"—the preference to retain ultimate decision-making authority during the shopping process; and (4) "I belong here"—the expectation of equal treatment as other consumers receive (Baker, 2006).

The aspiration of VICs to experience some or all these dimensions within retail environments, as well as the challenges they encounter in this regard, has been highlighted in numerous studies (Baker, Holland, and Kaufman-Scarborough, 2007; Kaufman-Scarborough and Childers, 2009; Ramatla and Mastamet-Mason, 2013; Yu, Tullio-Pow, and Akhtar, 2015; Çelik et al., 2019; Kara et al., 2020; Umut, Velioğlu and Eru, 2021; Çelik and Yakut, 2021). Additionally, the contribution of technology to enabling VICs to achieve consumer normalcy has also been identified as a significant finding in the literature (Kaufman-Scarborough and Childers, 2009).

The prerequisite for experiencing consumer normalcy in online shopping is compliance with accessibility standards. However, accessibility for VICs remains a significant challenge and inadequacy, both on websites and social media platforms, which are expected to ensure inclusivity and equal access for all (Raymond, Smith and Carlson 2024). For example, social media content, which plays a pivotal role in informing, comparing, and decision-making processes for consumers, is designed with accessibility considerations in mind in only a small fraction (approximately 5%) of cases (Raymond, Smith and Carlson, 2024). Similarly, while retailers' websites

adopt an inclusive approach that aims to embrace diverse consumer groups, they still fall short of achieving full accessibility. In the study by Çelik (2021), the compliance of Turkish retail chains' websites with accessibility standards was examined. Excluding CarrefourSA, which operates globally and achieves 90% compliance, other retailers, such as Migros, Şok Market, and A101, demonstrated an average ability of only 74% to create shopping platforms where VICs could shop independently without a need for assistance, using screen reader technologies. The accessibility of electronic marketplaces can be improved by ensuring that VICs have access to an accessible and secure payment mechanism, that can support the concept of consumer normalcy.

Crosier and Handford's (2012) study, titled "Customer Journey Mapping as an Advocacy Tool for Disabled People," visualizes the customer experience through a customer journey map focused on the end-to-end shopping process of VICs. This work clearly illustrates the challenges faced by VICs throughout their shopping journey. In this map, the final stage of shopping highlights a critical point: enabling VICs to complete their shopping independently by making a payment without assistance (Crosier and Handford, 2012). Assistive technologies such as Shop Talk, OrCam My Eye 2.0, Brailleback, Blindsquare, and VoiceOver, which are utilized by visually impaired individuals, significantly contribute to their shopping journeys and support visually impaired individuals' mobility, communication, and daily activities. These technologies converge on common functionalities such as identifying objects held by the visually impaired, providing verbal descriptions, and reading texts aloud. Their primary goal is to facilitate the lives of consumers and enable autonomy (Zor and Vuruşkan, 2019; Bolaños-Fernández and Bacca-Cortes, 2024). Although these technologies assist them during the shopping process, there remains a need for adjustments to payment terminals to enhance consumers' sense of trust and security, particularly during payment. In online shopping, fully accessible websites that comply with accessibility standards and are compatible with screen readers are important to address these concerns.

While assistive technologies have made shopping more accessible for visually impaired consumers, the digitalization of payment tools has introduced new challenges. As payment systems evolve, vulnerable groups, including those with visual impairments, may struggle to adapt due to impairments and a lack of digital literacy (ECB, 2022). The European Central Bank and national central banks point out the risk of excluding vulnerable groups, such as visually impaired consumers, from convenient and secure retail payments. Difficulty in access, lack of digital and financial literacy, and low trust in electronic payment solutions are seen as the main causes of that (ECB, 2022). To provide accessible retail payments for VICs, all those facts should be taken into consideration.

METHODOLOGY

The purpose of this study is to identify the dynamics of an accessible payment experience for visually impaired consumers while shopping. To achieve this goal, the research answers the research question by using sectoral practices and regulations and the existing body of knowledge in the literature. Within the scope of the study, a systematic literature review was conducted to analyze and interpret the findings obtained from articles, conference papers, and other documents related to the topic (Creswell, 2008) and synthesized with the outcomes of sectoral practices and relevant regulations. First, a manual Google Scholar search was used to gather data on sectoral practices and stakeholder actions pertaining to legislation that influence accessible payments. Then, with the dataset obtained from Scopus, Web of Science and Google Scholar, a systematic literature review was then conducted. The results and field practices were then combined through content analysis to enable a thorough discussion.

The systematic literature review was conducted based on the review framework formulated by Synder (2019). According to this framework, four key phases were fulfilled. First, in the *design phase*, the research question was determined, and the search strategy developed including search terms, databases, and inclusion/ exclusion criteria. Secondly, in the *conduct phase* the selection of relevant studies were done following the search strategy, and in the third phase, the *analysis* was performed by extracting and coding data from selected studies, analyses aligned with the research objectives, and ensuring quality control and consistency. Finally, the fourth phase *structuring and writing the review*, was carried out with a transparent and structured approach to presenting the results and contributions. These phases collectively ensure the rigor, reliability, and meaningfulness of the literature review (Synder, 2019).

The research begins by defining the research question based on the research objective.

RQ: How can an accessible payment experience be achieved for visually impaired consumers in retail to support consumer normalcy?

Specifying search terms and database repositories

To gather the literature about the subject, Scopus, Web of Science and Google Scholar were utilized as academic search engines with extensive database coverage.

The relevant literature was sought by employing the keywords "blind", "visually impaired", "payment", "accessibility","inclusion" in titles, abstracts, and keywords. With a focus on accessible payment systems for VICs in retail, those keywords were chosen to fully capture the pertinent literature for the systematic review. The terms "blind" and "visually impaired" specifically target the population for this study. The keyword "payment" has a clear connection to the review's focus, which identifies the payment solutions accessible to people with visual impairments. "Accessibility" emphasizes the significance of designing payment systems and technologies enabling all individuals to use, including the visually impaired. Finally, "inclusion" underlines a broader goal of guaranteeing that all customers, irrespective of disability, can fully participate in financial transactions. To refine the data from the database, the following search string was constructed: (TITLE-ABS-KEY (blind) OR TITLE-ABS-KEY (visually AND impair*)) AND TITLE-ABS-KEY (payment) AND TITLE-ABS-KEY (accessibl*) OR TITLE-ABS-KEY (inclusi*)).

As of November 2024, based on the query results from Scopus, research on accessible payments for visually impaired individuals remained limited. From the first study conducted from 2007-2024, a total of 24 publications were identified. Among these publications, 19.5% were in the field of medicine, 19.5% were in computer sciences, 12% were in social sciences, 9.8% engineering, 7.3% were in economics, and only 4.9% examined the subject from a business perspective. Rest of the studies were produced in diverse disciplines including decision sciences, art and humanities, etc. In addition to Scopus and Web of Science with similar query results, to reach a wider literature, a search was conducted in Google Scholar in November 2024, using the keywords "accessible payment" and "visually impaired", or "blind". These queries resulted in 29 publications for "accessible payment" and "visually impaired" and 56 publications for the keywords "accessible payment" and "blind". Finally, "financial inclusion" keywords were also applied together with "accessible payment", "blind" and "visually impaired". The total number of publications obtained from those database repositories was 109.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion	Rationale
Population	Publications focusing on directly VICs	Publications focusing on consumers with other sensory impairments	The study's focus is only visually impaired consumers.
Context	The publications addressing the "payment experience" of VICs	The publications with outcomes unrelated to VICs' payment experience	The study aims to understand visually impaired consumers challenges with payment tools in retail environment.
Time period	Publications in all time periods were included, from the first publication in 2007 till 2024.	No exclusion	A key goal of a scoping review is to assess the breadth of existing research; therefore, publications from every period were considered.
Methodology	All publications were included without making a discrimination based on the methodology adopted.	No exclusion	The study covers publications from different disciplines assessing the visually impaired payment tools and solutions to help analyze the literature's approach to VICs' inclusion in the retail environment.
Publication type	Journal article Conference paper Working paper	Thesis, books and publications without accessible full text, Duplicate publications	Including journal articles, conference papers and working papers aids in having an inclusive review covering the studies both by the academics and practitioners.
Language	Publications written in English and Turkish	Publications were written in non-English	Publications in other languages requires translation, which is excluded due to time and cost constraints.

Source: Compiled by the author (Thadikaran and Singh, 2025)

Determining Inclusion/Exclusion Criteria

Following the identification of the results using the selected keywords, the inclusion and exclusion criteria displayed in Table 1 were applied through a three-stage filtering process (Karsen, Chandra, Juwitasary, 2019). In the first stage, the publications identified through the keywords were categorized. The second stage involved reviewing the titles and abstracts of these publications to assess their relevance to the research question, with the shortlisted works classified as "candidate studies." Finally, in the third stage, the full content of the candidate studies was thoroughly analyzed, and those meeting the criterion were categorized as "selected studies." This systematic approach ensures a rigorous and focused selection of relevant literature (Karsen, Chandra, Juwitasary, 2019).

Relevance Appraisal

Relevant articles were manually chosen from the initial list, whereas irrelevant ones were excluded by analyzing their titles, keywords, abstracts, and full texts. Articles eliminated from consideration matched at least one of the exclusion criteria shown above.

Since the topic remains relatively underexplored within the academic literature due to its niche nature, the number of studies included in this review was limited to 16 publications, displayed in Table 2. That included two sources—a working paper and an article- which were incorporated through citation tracking of the included publications (Dai, et al., 2023). Following a thorough review of the complete publications, after extracting and coding data, emerging themes were: (1) payment tools used by VICs, their challenges, and their coping mechanism and (2) accessible payment terminals for inclusive payment experience.

FINDINGS and DISCUSSION

As demonstrated in Table 2, even if the oldest article was published in 2007, "accessible payments for visually impaired" subjects have been studied for the last ten years, most of them published in scientific journals, or conference proceedings. Researchers have focused mostly on Europe, but there are other studies from America (USA, Colombia), Asia (India, Indonesia Malaysia) and Africa (Nigeria).

EMERGING THEMES

The study aims to answer the research question of how to provide an accessible payment experience for VICs while shopping to support consumer normalcy. By demonstrating examples of best practices in the market, analyzing insights into the development of legal frameworks, and conducting a systematic literature review and content analysis, the findings obtained were synthesized under two overarching themes.

Payment Tools Used By Visually Impaired Consumers, Their Challenges, and Their Coping Mechanism

Under that theme, the payment tools available to VICs during transactions were categorized, and under each category the challenges they face, and their coping mechanism were articulated.

Cash Payments, Challenges and Coping Mechanism

Cash payments maintain its popularity, particularly due to the positive effects on VICs' increasing self-confidence and supporting autonomy while shopping, as well as the ease of tracking personal budgets and managing expenses. On the other side, reluctance to adopt digital payment methods because of low financial literacy can be compensated cash payments (Hernandez, Jonker, Kosse, 2017, Broekhoff et al., 2023; Van Der Cruijsen and Reijerink, 2024). Since VICs often encounter difficulties in adapting to digital payment systems, and the limited accessibility of these methods has led them to perceive cash as a more reliable and convenient alternative (Van Der Cruijsen and Reijerink, 2024).

To overcome potential difficulties in cash handling, VICs frequently adopt strategies like sorting and grouping their money in their wallets before shopping (Çelik et al., 2019). Additionally, they may be assisted by family members, ask for help from strangers, use money recognition tools, distinguish the currency by color, or recognize it through tactile features or written inscriptions (Kara et al., 2020). In Türkiye, the Central Bank introduced an inclusive approach to meet to the needs of VICs by adding features like "size differentiation, embossed printing dots, widespread embossed printing, and holographic stripe foil." This help VICs to detect banknotes value through braille alphabet applications, facilitate to make discrimination by altering the banknotes dimensions, and attempts to assist visually impaired users with developed security features offered by holographic stripe foils (TCMB, 2009). Additionally, in the same year, a program was launched to distribute money-measuring tools (Para-Ölçer) to VICs through relevant NGOs (TCMB, 2009).

Table 2: Findings of the Literature by Publication Year

Author/s & Publication year	Publication's title	Purpose & Findings	Country	Publication type
Broekhoff, M.C., van der Cruijsen, C., Jonker, N., de Haan, J. (2024)	"Toward financial inclusion: Trust in banks' payment services among groups at risk"	This research examines the trust of vulnerable consumers in the payment system. Findings indicate that consumers with low digital literacy, financial challenges, or visual impairments report below-average trust, attributing their concerns to dissatisfaction with bank policies, frequent service interruptions, and the ongoing digitalization of payment services.	Netherlands & Germany	Journal Article in *Economic Analysis and Policy*
Singh, S., Jatana, N., Sehgal, S., ... Arunkumar, B., Ramesh, J.V.N (2024)	"Making Digital Payments Accessible Beyond Sight: A Usability Study of UPI-Based Smartphone Applications"	The study evaluates accessibility issues in UPI (Unified Payment Interface) apps like Google Pay, Paytm, and PhonePe for visually impaired (VI) users. Testing revealed design flaws such as poor screen reader support and complex navigation, inadequate feedback mechanisms. It emphasizes redesigning these apps with user-centered improvements by developing the management of navigation, error feedback, and interface clarity.	India	Journal Article in *IEEE Access*
Bolaños-Fernández, C., Bacca-Cortes, E.B. (2024)	"Mobile Application for Recognizing Colombian Currency with Audio Feedback for VI People"	The study's focus is the problems of the VIs in identifying Colombian currency and introduces "CopReader," a smartphone app for VI users to recognize their currency offline using neural networks like MobileNetV2. Achieving 99% accuracy, it provides real-time audio feedback, enhancing financial independence and accessibility.	Colombia	Journal Article in *Ingeniería*
van der Cruijsen, C. and Reijerink, J. (2024)	"Uncovering the digital payment divide: Understanding the importance of cash for groups at risk"	The research aims to explore the role of cash in payment behavior. The findings support that cash is important for people with low digital literacy, suffering from disabilities like visual impairment, intellectual capacity, and low-income level.	Netherlands	Working Paper
Kurnia Ningrum, N.A., Fauzi, R., Suakanto, S. (2023)	"Designing an e-Wallet Solution for Users with Visual Impairment: A Design Thinking Perspective"	The study examines the VI's challenges in using e-wallet applications. It adopts a Design Thinking approach comprising "empathize, define, ideate, prototype, and test" phases to develop "Visipay," an accessible e-wallet solution tailored for VI users. The findings of usability tests point out the significance of 'user-centered design' in improving financial inclusivity and accessibility for underserved populations, emphasizing iterative prototyping and feedback-driven refinement.	Indonesia	Conference Paper
Singh, K., Gupta, S., Chawla, M., Rashid, G., Anand, U. Jain, R., Agarwal, A. (2023)	"Currency Recognition System for Visually impaired using a Novel CNN-LSTM based Hybrid Approach"	The study proposes a smartphone-based system to help the VIs recognize currency notes. Combining CNNs for feature extraction and LSTMs for sequence prediction, the model achieves a high level. It provides real-time audio feedback and is optimized for low-light conditions and cloud deployment, offering a robust, scalable solution for enhancing financial independence.	India	Journal Article in *Journal of Artificial Intelligence and Internet of Things*
Borowski-Beszta, M., Borowska-Beszta, B., & Polasik, M. (2023)	"Digital payment services in Poland as assistive technology and empowering tool for consumers with disabilities"	This study examines the adoption and perception of digital payment methods among consumers with and without disabilities in Poland. Findings show that individuals with disabilities actively use diverse payment services, including contactless payment cards. Digital payments are viewed as empowering tools that enhance financial control, and it's recommended to design inclusive digital financial services aligning with the needs of disabled people.	Poland	Journal Article in *Disability & Society*
Parvathy, V. and Durairaj, D. (2022)	"Adoption of Mobile Payment among Visually Impaired Users in Tamil Nadu based on TAM"	The study aims to explore the VICs' mobile payment adoption by employing Technology Acceptance Model. The findings reveal that the ease-of-use factor plays key role in adopting mobile payment since the users don't need to be assisted while performing the transaction via mobile application.	India	Journal Article in *International Journal of Health Sciences*, 5346–5361

Samuel, I., Ogunkeye, F.A., Olajube, A., Awelewa, A. (2020)	"Development of a Voice Chatbot for Payment Using Amazon Lex Service with Eyowo as the Payment Platform"	The study develops a voice chatbot using Amazon Lex and the Eyowo payment platform to facilitate financial transactions for the VI. It explores how a voice-based system can enable independent financial management through secure balance inquiries and money transfers. The findings show that the chatbot effectively uses speech recognition and natural language understanding to improve accessibility and financial inclusion.	Nigeria	Conference Paper
Kara, S., İnal, Ö., Torpil, B., Cemali, M., Tatlı, İ., Akı, E. (2020)	"Money Recognition and Using Methods in Visually Impaired Individuals"	The study examines the strategies that the VI employ for money recognition and usage, and the challenges they face. The findings highlight difficulties in money recognition, counting, and receiving change. Participants use various methods for money identification - tactile recognition, size comparison, and assistance from family or strangers.	Türkiye	Journal Article in *H.Ü. Sağlık Bilimleri Fakültesi Dergisi*
Kameswaran, V., Muralidhar, S.H. (2019)	"Cash, digital payments and accessibility – A case study from India"	This study examines VI individuals' challenges in using cash and digital payments. Findings reveal significant accessibility barriers in both payment modes, requiring additional effort necessary to navigate inaccessible systems.	India	Conference Paper
Guo, A., Kong, J., Rivera, M., Xu, F.F., Bigham, J.P. (2019)	"StateLens: A reverse engineering solution for making existing dynamic touchscreens accessible"	The StateLens project addresses the accessibility challenges faced by blind individuals when interacting with dynamic touchscreen interfaces. Utlizing 'a hybrid crowd-computer vision pipeline', it creates state diagrams, enabling interactive conversational agents and tactile exploration through 3D-printed accessories. User studies show the system effectively enhances independent access to touchscreens, offering a practical solution to significant accessibility barriers and fostering inclusivity.	USA	Conference Paper
Braeken, A. (2017)	"An Improved E-Payment System and Its Extension to a Payment System for Visually Impaired and Blind People with User Anonymity"	The study proposed an improved e-payment system using the ASEC protocol for enhanced security and privacy by integrating user anonymity, securing transactions, and accessibility, for the VI. The proposed system enables VI users to perform their transactions autonomously by using their smartphones while dealing with nonrepudiation, forward secrecy, and mutual authentication issues. This innovative solution improves accessibility without requiring significant hardware modifications, making it a practical option for inclusive payment systems.	Belgium	Journal Article in *Wireless Pers Commun.*
Wong, E.J., Yap, K.M., Alexander, J., Karnik, A. (2017).	"Design and Analysis of Haptic-Audio Based System for Visually Impaired to Shop Online"	This study explores whether the VI individuals can shop online independently. A system using haptic feedback and voice recognition was developed, allowing users to browse products, interact with the shopping cart, and make payments through a voice-password system. The results show that these technologies enable independent online shopping for visually impaired users.	Malaysia & UK	Journal Article in *Journal of Telecommunication, Electronic and Computer Engineering*
Pino, B., Sánchez, M. D., and Sancha, Z. (2014)	"Toward Payment Systems for All: Accessible POS"	The study explores the development of an accessible payment system for VI individuals to ensure independent and secure transactions. It identifies challenges in traditional POS devices, which rely on visual information and often require external assistance and offers an auditory feedback system integrated into POS devices, providing distinct tones to indicate transaction steps with a user-centered design approach.	Spain	Journal Article in *Journal of Accessibility and Design for All*
Anderson, R.G., Williams, M.M., (2007)	"Currency design in the United States and abroad: counterfeit deterrence and visual accessibility"	The study focuses on currency design's visual accessibility and ability to combat counterfeiting. It underlines the integration of tactile markers and high-contrast numerals as security features with accessibility for visually impaired users. The findings underline the importance of public awareness and technological advances in the reliability and use of banknotes.	USA	Journal Article in *Review*

As technology has advanced, mobile applications designed to assist VICs with money recognition have become widely used by the VICs (Çelik et al., 2019; Singh et al., 2023). One of the commonly used applications in Türkiye is "Cash Reader", which can identify different currencies aloud and operates offline. Similarly, Turkish telecommunication company -Türk Telekom developed the "Accessible Life" (Erişilebilir Yaşam) application, and offered free of charge (Cash Reader, n.d.; Türk Telekom, n.d.). Another example is "CopReader", a Colombian app that identifies the value of a currency by capturing its image via video or photo and provides this information to the user through auditory feedback (Bolaños-Fernández and Bacca-Cortes, 2024). While these mobile applications offer valuable assistance, smart glasses have been proposed as well. However, smart glasses' inability to process data independently while requiring constant internet connectivity and support from remote servers has been perceived as a limitation in their usability. Because of this limitation, applications operating offline are a more favorable for VICs (Lin et al., 2020).

An additional concern about cash payment is detecting counterfeit currency not only for VICs but also for all consumers. Therefore, counterfeit detection has been an important element of managing financial transactions securely. Ugale, Tambe, Kurhe, and Shubham (2023) focused on this issue in their study, pointing out the need for accessible tools to verify counterfeit banknotes. The integration of security features with tactile markers and high-contrast numerals would further strengthen the security and autonomy of VICs while performing financial transactions (Anderson and Williams, 2007).

Credit or Debit Card Payments, Challenges and Coping Mechanisms

In addition to cash payments, VICs can also use payment cards to avoid fraud or mistakes but always keep the fear of being cheated in mind (Kara et al., 2020). However, payment cards are preferred over complicated banking apps and wallets that need smartphone use and application setup, due to their perceived financial control and ease-of-use (Borowski-Beszta, et al., 2023). Thus, companies increasingly integrate inclusivity into their innovations for credit or debit card payments to make VICs' lives easier. For instance, Mastercard introduced an innovative card design in Türkiye in 2021, allowing VICs to distinguish among credit cards, debit cards, and prepaid cards in their wallets. This initiative, called the "Touch Card", features tactile notches on the side of the card: (1) a round notch for credit cards, (2) a wide square notch for debit cards, and (3) a triangular notch for prepaid cards. For VICs, this design offers a more creative and inclusive option than the conventional embossed names and numbers, which are being phased out in many cards (Selimoğlu, 2021).

Both credit and debit cards are preferred for transactions, especially those that don't require a PIN and allow contactless payments. Debit cards are particularly favored for their ease-of-use and capability of tracking expenses more effectively (Broekhoff et al., 2023). Similarly, contactless credit card payments also offer convenience. To improve security and ease-of-use, the Thales Voice Payment Card was developed in collaboration with the French fintech company Handsome. This card connects with a smartphone application through Bluetooth, offering audio feedback on transaction details about amount, PIN validation, and payment confirmation, providing a secure and accurate experience. Compared to existing EMV (European Mastercard Visa) payment terminals that do not require hardware upgrades, it doesn't necessitate extra accessories while focusing on simplicity, security, and inclusivity. By dealing with common issues like fraud and errors during transactions, this technology demonstrates Thales's commitment to developing accessible, equitable payment systems for all users. In Türkiye, Papara, a fintech company, first launched this Voice Card into the market in collaboration with Thales in 2022 and it can be seen as a good practice example (Thales, n.d.).

Finally, as a safer payment option in online shopping, VICs have been observed to consider virtual cards. Additionally, when they prefer 3D secure payment systems for enhanced security, a common challenge arises: the insufficient time provided to enter the code sent via SMS into the website (Çelik et al., 2019). This issue, while minor, is a significant barrier and represents a small but crucial step to be taken to ensure an inclusive payment experience (Broekhoff et al., 2023).

Digital Payment, Challenges and Coping Mechanisms

Digital payment options can be utilized by VICs in physical retail stores for contactless payments via smartphones, tablets, or smartwatches. Digital payment apps, equipped with screen readers and voice-over capabilities, can make financial transactions easier for VICs. Even if those applications may offer accessibility for VICs, they may still include design flaws related to screen reader compatibility, keyboard navigation, and the clear labeling of buttons and controls (Singh et al., 2024). At this point, the digital skills of VICs also become crucial. Broekhoff et al. (2023) revealed that the VICs tend

to have lower levels of trust in the payment services offered by their banks. Moreover, as the level of digital skills decreases, their trust in payment services also diminishes. This finding highlights that accessibility issues encountered by VICs when digital or physical payment systems are used, negatively impact their trust levels.

In online shopping, sellers must improve inclusivity by developing accessible websites that comply with accessibility standards and providing mobile payment options that are both accessible and user-friendly during the payment step. For VICs, both ease-of-use and accessibility play critical roles in adopting mobile payment methods (Parvathy and Durairaj, 2022). At this point, incorporating payment systems such as PayPal and Google Wallet, which prioritize accessibility, into payment acceptance processes is vital for creating an inclusive payment experience. Digital wallets, which securely store financial information like credit/debit cards and e-money accounts, ensure that the recipient of the payment cannot access the user's financial details (PAL, 2020).

As an example of developing e-wallet solutions for VICs, the 'VisiPay' application in Indonesia,demonstrate the progress in improving digital payment inclusivity (Kurnia Ningrum et al., 2023). VisiPay adopted the design thinking methodology and followed inclusive product development process by beginning with analyzing the needs of VICs. The outputs of this analysis help identify their challenges such as "lengthy transaction processes, issues with screen readers' ability to read certain elements, and access barriers like facial recognition". In the end, a user-friendly interface was developed, offering a level of accessibility comparable to that of sighted users. Beside VisiPay, another innovative system utilized the potential of artificial intelligence to develop a voice-based chatbot payment system using Amazon Lex and the Eyowo payment platform. The proposed system allows users to transcribe spoken commands into text and transactions can be executed based on the text input. Voice commands are processed by the system, appropriate responses are developed and shared with the user through speakers. The test results showed that the voice-enabled chatbot successfully executed financial transactions, providing a secure and comfortable user experience (Samuel et al., 2020). On the other hand, as a well-known NGO, the European Blind Union (EBU) emphasized that if visually impaired or vision-restricted consumers use a smartphone or smartwatch as a payment tool, the payable amount should be displayed on their device before the transaction is approved. Additionally, if the payment is made via a card, the transaction amount should be verifiable or rejectable through alternative secure methods like banking applications or phone notifications (EBU, 2023).

For VICs, "navigating complexly designed websites" and "entering card information into payment forms during online transactions" are common accessibility barriers in online shopping. A voice-based password payment system has been proposed as a potential solution to automate data entry process into the form and improve independency of the visually impaired while making online payments (Wong et al., 2017).

Wearable technologies also offer additional solutions to facilitate mobile payments for VICs. For example, the "Shimmer" device, currently available in the Asian market, operates as a contactless payment terminal worn around the neck. It has features like as a braille keyboard, a fingerprint scanner, a camera, and a screen that displays QR codes to support QR code-based payment processes (Bigumigu, 2023).

These examples illustrate ongoing efforts to achieve financial inclusion, defined as "a process that ensures access to, availability of, and ease of use of the formal financial system for all members of an economy" (Sarma and Pais, 2011). Without such initiatives, systems that limit financial access will lead to their financial exclusion for vulnerable groups (Leyshon and Thrift, 1995). To prevent this, adopting human-centered design principles is fundamental. This approach involves understanding the needs of diverse consumer groups and creating solutions based on user insights through an empathetic approach. A prototype is then developed to bring the solution to life, tested on the market, and, if effective, introduced to ensure that inclusive products meet consumer needs (Pian, 2018).

Accessible Payment Terminals for Inclusive Payment Experience

Under that theme, VICs' challenges in payment process through payment terminals are presented under *challenges with payment terminals*, and the initiatives of NGOs, governments and companies are articulated under the *actions taken by stakeholders* category.

Challenges with payment terminals

One of the primary challenges faced by VICs while shopping is the lack of trust and security in the payment process, which restricts their independence and creates

significant discomfort. Key concerns include verifying whether the price of purchased goods or services is accurate, ensuring correct cash payments and receiving proper changes, avoiding fraud during credit card transactions, and addressing the inaccessibility of POS devices. These issues constitute the core difficulties experienced by VICs during payment processes (Zufelt, 2010; Pino, et al., 2014; Yu, et al, 2015; Çelik, et al., 2019; Umut, et al., 2021). Studies focusing on these challenges consistently emphasize the importance of voice-assisted systems in payment processes (Pino, et al., 2014; Çelik, et al., 2019; Umut, et al., 2021). For example, Pino, et al. (2014) advocate the use of auditory feedback to guide VICs through payment steps. Their proposed system includes distinct voice signals to inform users about the critical stages, such as "successful card reading, the need for PIN entry", during payment transactions. Guo et al. (2019) proposed the StateLens system, which reconstructs a structured model of the interface and provides audio and conversational instruction to make dynamic touchscreens accessible for blind users. It offers interactive guidance via conversational agents accompanying the user during transaction. Additionally, with 3D-printed accessories, it prevents unintentional touches on capacitive screens and facilitate nonvisual use. Since touchscreens often pose significant accessibility challenges for blind users because of their inherently visual nature, the risk of unintended interactions during transaction, and the lack of options to modify or select more accessible platforms, this system transforms inaccessible devices into navigable tools. In that way the aim of enhancing the independence and usability for visually impaired individuals can be achieved (Guo et al., 2019).

Actions taken by the Stakeholders

Visually impaired individuals have lower-than-average levels of trust in payment systems provided in digital banking (Broekhoff et al., 2024). At this point, one of the critical tools to strengthen the autonomy of VICs while shopping, increase their self-confidence and make them feel comfortable in retail environment is the availability of reliable payment terminals. For this issue, the European Blind Union (EBU) successfully advocated for the inclusion of payment platforms in *the European Accessibility Act*, introduced by the European Commission in 2015, to improve market accessibility for elderly people and those with visual impairments. With this Act a regulatory framework was established to mandate all products and the payment terminals introduced after June 28, 2025, must meet accessibility standards. Those will be the operational parameters to be obeyed for industry stakeholders. That action signifies a remarkable advancement in developing inclusivity and equity in the market. Additionally, the EBU's Payment Terminals Working Group published recommendations to provide valuable insights into user needs and expectations and they offer guidance to manufacturers on designing payment terminals aligned with the principles of universal design. These recommendations serve as invaluable resources, promoting the development of inclusive payment systems while catering the unique needs of visually impaired users (EBU, 2020).

With these recommendations EBU emphasize the need for tactilely distinguishable buttons with appropriate size, the provision of haptic feedback through vibrations to confirm button activation, and the integration of tactile overlays for flat touch panels to increase accessibility. Additionally, as a general principle, payment terminals should have large, easily readable screens, a speaker to enable auditory feedback, and either a standard 3.5 mm headphone jack or an alternative mechanism for audio transmission (EBU, 2023). There are studies drawing the attention the accessibility challenges of blind individuals while interacting with dynamic touchscreen interfaces and propose the use of a hybrid crowd-computer vision pipeline, which creates state diagrams that enable interactive conversational agents and tactile exploration through 3D-printed accessories (Guo, et al.,2019).

Additionally, to ensure a fully accessible user interface (UI), specific visual, auditory, and speech-related features have been remarked as necessary by EBU. Their recommendations not only include blind users but also the users with low vision and they advise to customize the interface by adjusting the text size, text/background color, screen brightness, and similar settings, all in a user-friendly and easily accessible manner. The interface should provide voice commands for key transaction stages, such as "card entry,""amount to be paid,""PIN entry,""contactless payment confirmation," and "transaction status" (success/failure). Speech-related functionality is also emphasized, with recommendations for allowing customization of the speech voice, specifying the amount to be paid, editing the entered PIN, and performing all functions related to transaction steps and messages through speech interaction. These features are considered critical for achieving an inclusive and accessible user interface (EBU, 2023).

In the U.S., the *Americans with Disabilities Act* also requires banks to comply with the accessibility rules for their online banking and mobile apps that disabled people may utilize while shopping for payment. The

main requirements for accessibility to be followed to make their services accessible include screen reader compatibility with alternative text for images, proper headings and structures, keyboard navigation, focus indicators, color contrast and text scaling, contrast ratios and text scaling (Milbergs, 2024).

In Canada, at the federal level, the *Accessible Canada Act* allows the development of accessible electronic payment terminals (Government of Canada, n.d.). In 2024, with the funding of the Government of Canada, accessible payment terminals project was realized through the collaboration of CNIB(Canadian National Institute for the Blind) and Moneris® Core corporation. Electronic payment terminals featuring accessibility modes for both touchscreen and manual payment terminals were launched into the market. These payment terminals enable VICs to independently navigate the terminal using audio prompts and a high-contrast screen, without the need to disclose their PIN or request assistance (CNIB, n.d.).

In Türkiye Yapı Kredi Bank introduced the "Engelsiz POS" (Accessible POS) device in collaboration with Ingenico and the Six Point Blinds Association as a stakeholder in an R&D project. This initiative, first in both Turkey and globally, introduced the device into the market in 2011. The POS terminal, which was part of the Ingenico iCT series, was equipped with a specially integrated audio module enabling the VICs to hear the transaction amount through auditory prompts while shopping and receive voice feedback on the accuracy of their PIN entry, aiming to address and mitigate their security concerns regarding payments (BT Haber, 2011; Yapı Kredi, n.d.). Despite its innovative design and potential impact, the adoption and widespread use of this POS device in the market remain limited, and its overall effect appears to have been constrained.

In the UK, Ingenico collaborated with RNIB(the Royal National Institute of Blind People) on a project focused on accessible payment terminals with touchscreens, aiming to provide blind and partially sighted individuals with a secure method to input their PIN on touchscreen POS devices. They developed a new interface for the Android AXIUM series with input from blind and partially sighted individuals through user testing, effectively accommodating various levels of visual impairment. For example, the AXIUM DX8000 leverages its large color touchscreen and text-to-speech functionality to provide an accessible and PCI-approved solution, ensuring the secure entry of PINs (Ingenico, 2023).

Aligned with these features, accessible payment terminals can contribute to establishing the "two-sided market" structure described by economists. A two-sided market refers to a platform or system that facilitates interactions between two distinct participant groups, enabling mutually beneficial transactions that would otherwise occur inefficiently. The key characteristic of a two-sided market is the platform's ability to create value by connecting participants from both sides, often incentivizing engagement through reduced transaction costs or increased benefits. Credit card networks linking consumers and businesses, online marketplaces connecting buyers and sellers, and ride-sharing platforms pairing drivers and passengers are of examples two-sided platforms that facilitate interactions between distinct user groups. (Zywicki, 2010).

In the context of a two-sided market, the adoption of accessible payment terminals for VICs eliminates a critical barrier by facilitating seamless interactions between VICs and retail businesses. These terminals, akin to the role of credit card networks in enabling transactions (Morris, 2024), act as intermediaries that provide inclusivity and enable the transactions to be completed that might otherwise be limited by accessibility challenges. This approach not only enhances the inclusivity of financial systems but also supports sustained participation and value creation for both VICs and retail businesses.

THEORETICAL IMPLICATIONS

The findings of this study enlighten the role of designing accessible payment systems in customer journey to address the elements of consumer normalcy, particularly 'I'm in control' and 'I belong here,' in the shopping experience of visually impaired individuals. Inclusive payment systems enable visually impaired consumers to make secure payments and independently complete their shopping, just like other consumers. From that point of view, findings also offer significant theoretical implications for understanding and advancing accessibility in financial systems, particularly for VICs. First of all, it enhances the definition of financial inclusion not only "the share of the population who use financial services with a multitude of dimensions, reflecting the variety of possible financial services, from payments and savings accounts to credit, insurance, pensions, and securities market (WB, 2014)", but also with a new definition "a process ensuring equitable access to financial tools, including the accessible payment systems which eliminates the barriers faced by VICs and enabling them to experience consumer normalcy". As accessible payment systems can be seen as a component

of consumer normalcy while shopping, the relation between financial inclusion and consumer normalcy should be emphasized in the literature for future research.

The findings of the study also point out that to design accessible retail environments, accessible payment systems should also be considered to support visually impaired consumers' autonomy and inclusion in the marketplace. Since, under the current circumstances, the VICs feels "the state of powerlessness arising from an imbalance occurring during marketplace interactions (Baker, 2006)" which may make them feel vulnerable in the marketplace. To decrease the level of consumer vulnerability, accessibility should be evaluated as not only a moral imperative but also an economic necessity that will be utilized by both consumers and service providers through broader market participation.

Another theoretical implication can be about the accessibility's role in the visually impaired consumers' technology adoption, besides the perceived ease of use and trust. Aligning with Technology Acceptance Model, accessibility can be considered as a crucial determinant of these perceptions, which may require integration into consumer behavior models. Besides, the role of coping mechanisms, such as reliance on tactile features, assistive technologies, or mobile applications, expands the understanding of adaptive consumer behaviors in constrained environments.

Conclusion

Visual impairments or reductions in visual capacity, coupled with increasing life expectancy and a growing elderly population, have heightened the need for inclusive design in goods and services. Supporting the independence of visually impaired consumers during their shopping experiences requires that the design of services offered to them be inclusive, aligned with their current needs and expectations, and that the payment step of the shopping process should be considered. To achieve this goal, it is crucial to closely examine the payment tools used by visually impaired consumers in both physical and online shopping contexts, addressing the challenges they face and offering accessible solutions for them. This will enable the delivery of messages such as "you are in control" and "you belong here," which are fundamental for fostering consumer normalcy in the retail environment. In this way, VICs could be able to independently manage a seamless shopping process, co-creating the experience with sellers while feeling comfortable, and could be treated equally without discriminated based on their impairments.

In this study, the use of various payment tools, including cash, virtual, credit, and digital payment options, was discussed, along with the challenges faced and their coping strategies. Among the prominent factors for ensuring the inclusivity of payment methods are their accessibility, achieved through compatibility with assistive technologies; their usability, facilitated by a user-friendly interface; and the integration of voice command systems, which help VICs feel secure during payment transactions. In particular, the delivery of accessible digital payment systems developed with a design-thinking approach to VICs would provide their financial inclusion in the market, empowering consumer normalcy. By using the Braille alphabet, tactilely distinguishable buttons, haptic feedback through vibrations to guide payment steps, and integrating tactile overlays for flat touch panels, along with conversational and audio features in a user-friendly interface, VICs can complete their shopping experiences with their independence fully supported throughout the physical shopping process. In online shopping, providing VICs with user-friendly, accessible websites that are easily adaptable for screen readers, comply with WCAG guidelines, and leverage new AI-powered technologies through a design thinking approach is crucial for enabling VICs to experience consumer normalcy in retail environments.

Eliminating accessibility barriers addresses the trust and security concerns that consumers may experience while shopping. Achieving financial inclusion necessitates the widespread adoption of accessible payment terminals, which are crucial for enabling VICs to conclude their transactions with confidence. Drawing on the example of the "Accessible POS" initiative by Yapı Kredi Bank in Türkiye, which failed to achieve sustained implementation, it can be argued that if market demand for inclusive products does not arise spontaneously, policymakers should introduce regulations mandating the use of such products to ensure financial inclusion.

The widespread adoption of inclusive practices in the market is made possible through the effective participation of nongovernmental organizations (NGOs) as stakeholders in relevant processes, as exemplified by the European Blind Union. At this juncture, it is imperative for public authorities to ensure the active involvement of pertinent NGOs as stakeholders in establishing the legal framework concerning practices that may impact the lives of individuals with disabilities. Moreover, all

the steps undertaken within these accessibility and financial inclusion initiatives should be embraced and executed through a human-centered design thinking approach accompanied by the advocacy group's support about monitoring compliance with the accessibility standards and their needs. Adopting this approach could help prevent financial exclusion for individuals with disabilities, ensure inclusivity, and establish a two-sided market structure. And providing seamless interactions between VICs and retailers, would create value for both consumers and businesses, redefining market inclusivity as a strategic advantage.

LIMITATIONS and FUTURE DIRECTIONS

The primary limitation of this study is its reliance solely on secondary sources of accessible payments for VICs. In this context, conducting a field study in Türkiye that directly engages visually impaired consumers could provide a more concrete understanding of their challenges and proposed solutions, contributing to the design of a more inclusive payment experience. Nevertheless, the present study offers originality by combining theoretical contributions with practical insights and recommendations. This dual approach is expected to guide practitioners in the market by promoting more inclusive designs in customer communication and customer journey mapping, enabling businesses to better address the needs and expectations of their visually impaired customers in retail.

Although accessible payments in retail are currently perceived as a niche subject with limited interest from practitioners, the concepts of inclusivity and equality are increasingly gaining prominence on the global agenda as part of the Sustainable Development Goals. Therefore, further research could focus on the design of disability-friendly environments. Such studies should not only focus on sensory impairments but also encompass other forms of disability, including cognitive impairments. Furthermore, given the aging populations in many countries, there is a critical need to redesign goods and services based on the field research findings to ensure they are accessible and inclusive for all.

DECLARATION OF GENERATIVE AI IN SCIENTIFIC WRITING

During the preparation of this work, the author used Chatgpt to improve the readability and language of the manuscript. After using this tool, the author reviewed and edited the content as needed and took full responsibility for the content of the published article.

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