REVIEW ARTICLE

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Neuromanagement decision making in facial recognition biometric authentication as a mobile payment technology in retail, restaurant, and hotel business models

JEL Classification: *E42; J33; O14*

Abstract

Research background: With growing evidence of biometric identification techniques as authentication, there is a pivotal need for comprehending contactless payments by use of facial recognition algorithms in retail, restaurant, and hotel business models.
Purpose of the article: In this research, previous findings were cumulated showing that harnessing facial recognition payment applications as software-based contactless biometric algorithms results in remarkably qualitative enhancement in purchasing experience.
Methods: Throughout March and November 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms including "facial recognition payment technology", "facial recognition payment system", "facial recognition payment application", "face recognition-based payment service", "facial authentication for mobile payment transactions", and "contactless payment through facial recognition algorithms." As the analyzed research was published between 2017 and 2021, only 187 articles satisfied the eligibility criteria. By removing questionable or unclear findings (limited/nonessential data), results unsubstantiated by replication, too general content, or having quite similar titles, 38, mainly empirical, sources were selected. The Systematic Review Data Repository was harnessed, a software program for the gathering, processing, and analysis of data for our systematic review. The quality of the selected scholarly sources was assessed by employing the Mixed Method Appraisal Tool.
Findings & value added: Harnessing facial recognition payment applications as software-based contactless biometric algorithms results in remarkably qualitative enhancement in purchasing experience. Subsequent attention should be directed to whether perceived value and trust shape customers' adoption of biometric recognition payment devices.

Introduction

Software-based facial recognition is a biometric identification technique that harnesses deep learning algorithms (Levy & Barocas, 2018; Monajemi, 2018; Norfolk & O'Regan, 2021; Pantano, 2020; Zhao *et al.*, 2020) to inspect and process data subsequently contrasted with image databases to check user identity (Ciftci *et al.*, 2020; Lau, 2020; Venkatesan *et al.*, 2021; Xu *et al.*, 2021; Yang *et al.*, 2020), and can be deployed to secure payments made by use of tablets, smartphone, or smartwatches (Cham *et al.*, 2021; Dang *et al.*, 2021; Daragmeh *et al.*, 2021; De Keyser *et al.*, 2021) in retail, restaurant, and hotel business models. The objective of this systematic review is to inspect recently published literature on how biometric systems are crucial in differentiating customers by use of their personal data (Hurley & Popescu, 2021; Kovacova & Lăzăroiu, 2021; Lăzăroiu & Harrison, 2021; Peters, 2022), through the adoption of automated systems (Mitchell *et al.*, 2021; Nica *et al.*, 2021; Suler *et al.*, 2021; Wade *et al.*, 2021) to identify persons according to their biological and behavioral attributes.

We want to elucidate whether, being pivotal in gathering biometric data, face recognition is extensively deployed in accessing control systems

demanding monitoring areas. Facial recognition payment assists customers in carrying out transactions in a few seconds. Rapid check-in and transactions by use of facial recognition payment result in significant enhancement in service performance and security.

By analyzing the most relevant (the Web of Science, Scopus, and ProQuest) and recent (2017–2021) sources, we attempt to prove that categorization and object detection algorithms are decisive in digital image processing and computer vision. In our research, we cumulate prior published findings clarifying that, by identifying and configuring feature vectors without the need of physical contact, facial recognition payment technology is instrumental in optimizing time management, performance, and precision. The research problem developed extensively throughout the systematic review is whether customers' shopping experience can be progressively comprehended (Bennett, 2021; Birtus & Lăzăroiu, 2021; Popescu *et al.*, 2021a; Riley & Nica, 2021) by use of facial recognition big data systems in retail, restaurant, and hotel sectors.

Research Problem 1: As machine learning-based payment systems can optimize the efficiency of face-based transactions, customer adoption behaviors of innovative technologies (Bacalu, 2021; Griffin & Krastev, 2021; Olsen, 2019; Pelau *et al.*, 2021; Welch, 2021) integrate facial recognition services in retail, restaurant, and hotel business models as regards trust, security, and privacy. The growing integration of facial recognition big data systems in retailing may assist employees to in progressively comprehending customers' shopping experience (Androniceanu *et al.*, 2020; Johnson & Nica, 2021; Lăzăroiu *et al.*, 2021; Morrison & Lăzăroiu, 2021) by leveraging of deep learning operations (Gibson & Macek, 2021; Kassick, 2019; Nica, 2021; Novak *et al.*, 2021), categorization and object detection algorithms (Balica, 2019; Blackburn & Pera, 2021; Platt, 2021; Riley *et al.*, 2021) are now decisive in digital image processing (Blake & Frajtova Michalikova, 2021; Konhäusner *et al.*, 2021; Mitchell, 2021; Robinson *et al.*, 2021) and computer vision (Adams & Krulicky, 2021; Blake *et al.*, 2021; Chapman, 2021; Ionescu, 2020).

Research Problem 2: Technological developments and the integration of sensors into smartphones have enabled biometric capture and analysis (Campbell *et al.*, 2021; Ford, 2021; Galbraith & Podhorska, 2021; Woods & Miklencicova, 2021) as video cameras enable customer tracking and can be optimized by facial detection systems and video analytics in retail, restaurant, and hotel business models.

Research Problem 3: Facial recognition constitutes the most adequate way of biometric identification in payments by not necessitating any physical interaction by the customers, as machine learning algorithms can be

harnessed to systematically appraise (Burke & Zvarikova, 2021; Hamilton, 2021; Mihăilă & Braniște, 2021; Nica & Stehel, 2021) retail service encounters by use of customers' facial expressions. Financial innovative transaction tools and smart payment services reconfigure consumer buying patterns and technological capabilities (Mircică, 2020; Townsend, 2021; Valaskova *et al*., 2021; Watkins, 2021) as face recognition algorithms can be thoroughly harnessed to the confirmation of mobile payment in retail, restaurant, and hotel business models.

Research Problem 4: Software-based facial recognition tools are a groundbreaking contactless biometric technology shaping consumer perceptual (Adams *et al*., 2021; Barbu *et al*., 2021; Morrison, 2021; Popescu *et al*., 2021b; Stehel *et al*., 2021), behavioral (Ciobanu *et al*., 2019; Nica *et al*., 2019; Turner & Pera, 2021; Woodward & Kliestik, 2021), and purchase intentions (Bailey, 2021; Olssen, 2021; Wallace & Lăzăroiu, 2021; Wingard, 2019) to adopt contactless payment methods, such as facial recognition and mobile payment services and apps in retail, restaurant, and hotel business models.

The manuscript is organized as following: theoretical overview (section 2), methodology (section 3), software-based facial recognition tools as a groundbreaking contactless biometric technology for payments (section 4), machine learning algorithms and facial recognition big data systems in retail, restaurant, and hotel sectors (section 5), digital image processing and computer vision in software-based facial recognition technology (section 6), privacy and security concerns triggered by use of software-based facial recognition technology (section 7), discussion (section 8), conclusions (section 9), and limitations, implications, and further directions of research (section 10).

Theoretical overview of the main concepts

Hardware-based facial recognition technologies enable biometric authentication (Ciftci *et al.*, 2021; Lai & Rau, 2021; Liu *et al.*, 2021; Moriuchi, 2021; Zhong *et al.*, 2021) for authorizing purchases and making payments in retail, restaurant, and hotel business models. Convenient contactless in-store payment is expedited, but users' security and privacy issues may counterbalance amplified checkout efficiency of facial recognition payments (Du, 2018; Li *et al.*, 2019; Wójtowicz & Chmielewski, 2017; Zhi & Liu, 2019), as retina composition cannot be replicated and biometric data are stored as an encrypted code.

Cutting-edge camera systems can investigate more than tens of thousands of dots on customers' faces to configure a biometric map connected with an infrared shot and correlate the collected data preliminarily entered by users in retail, restaurant, and hotel business models (Cham *et al.*, 2021; Dang *et al.*, 2021; Daragmeh *et al.*, 2021; De Keyser *et al.*, 2021), being accurate enough to recognize spoofing, by differentiating a real individual from a 2D picture or a 3D-printed mask, and thus artificial intelligence-based neuromanagement decision making is pivotal in technological applications of economic processes.

Facial recognition constitutes a groundbreaking performance of payment platforms that facilitates customers' digital transactions (Aljanabi *et al.*, 2018; Church, 2018; Feng *et al.*, 2017; Palm, 2018; Poole, 2017) with an advanced 3D snapshot throughout the minimized checkout operation, easing and enhancing their retail, restaurant, and hotel experiences in terms of operational economics. Retailers can thus organize more self-check-out lanes in shopping centers while providing cutting-edge offerings in the payment ecosystem. Technological management processes integrate machine learning algorithms and mobile commerce applications, reconfiguring virtual and augmented reality shopping experience by use of facial recognition payment.

For facial authentication during mobile payment transactions in stores, cafeterias, and restaurants (Ciftci *et al.*, 2020; Lau, 2020; Venkatesan *et al.*, 2021; Xu *et al.*, 2021; Yang *et al.*, 2020), customers can employ a mobile app to register and transfer money for shopping. Their names and pictures are subsequently listed on the shop's own app and a click on the photo made by cashiers after automated facial identification completes the transactions, optimizing operational management practices and strategies (Androniceanu, 2019; Androniceanu, 2021; Haseeb *et al.*, 2019; Siekelova *et al.*, 2017), and developing emerging business trends associated with the metaverse economy.

Facial recognition-powered payment technologies can leverage a 3D biometric system and validate customers' identity (Andrejevic & Selwyn, 2020; Elloumi *et al.*, 2021; Kostka *et al.*, 2021; Seng *et al.*, 2021; Yang, 2020) by inspecting their distinguishing characteristics by use of a USB camera. Alternatively, customers can download an iris payment app, take a close-up selfie, the particular pattern is stored encrypted by the app, and then employed as a match to carry out each transaction in front of a terminal, thus enhancing business operations through artificial intelligence-based neuromanagement decision making. Customers can register for facial recognition payments by sharing encrypted biometric data processed and transferred through secure channels (Kim *et al.*, 2019; Liu &

Tu, 2021; Lott, 2018; Zhang & Kang, 2019; Zhang *et al*., 2020), while identity theft undertakings are blocked by a 3D camera that assesses the depth of a user's physiognomy, building consumer trust, attitude, intention, acceptance, engagement, satisfaction, and loyalty.

For contactless biometric retail payments by use of facial recognition algorithms at self-service checkout terminals in convenience stores (Levy & Barocas, 2018; Monajemi, 2018; Norfolk & O'Regan, 2021; Pantano, 2020; Zhao *et al*., 2020), customers download a smartphone application, enter their phone number, register their facial biometrics, and connect a payment card to the built-in anti-spoofing system, consequently reshaping retail, restaurant, and hotel business models.

Method

A systematic review of recently published literature was conducted on facial recognition biometric authentication as a mobile payment technology in retail business models by employing Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. The inclusion criteria were (i) sources indexed in the Web of Science, Scopus, and ProQuest databases, (ii) publication date between 2017 and 2021, (iii) written in English, (iv) being an original empirical research or review article, and (v) particular search terms/phrases covered; (i) conference proceedings, (ii) books, and (iii) editorial materials were eliminated from the research.

The Systematic Review Data Repository (SRDR) was harnessed, a software program for the gathering, processing, and analysis of data for our systematic review. The quality of the selected scholarly sources was assessed by employing the Mixed Method Appraisal Tool. Extracting and inspecting publicly accessible documents (scholarly articles) as evidence, no institutional ethics approval was needed before beginning our research. (Figure 1)

Throughout March and November 2021, a quantitative literature review of the Web of Science, Scopus, and ProQuest databases was carried out, with search terms including "facial recognition payment technology", "facial recognition payment system", "facial recognition payment application", "face recognition-based payment service", "facial authentication for mobile payment transactions", and "contactless payment through facial recognition algorithms", which are the most used words or phrases across the inspected literature.

As the analyzed research was published between 2017 and 2021, only 187 articles satisfied the eligibility criteria. By removing questionable or

unclear findings (limited/nonessential data), results unsubstantiated by replication, too general content, or having quite similar titles, 38, mainly empirical, sources were selected (Tables 1 and 2).

Software-based facial recognition tools as a groundbreaking contactless biometric technology for payments

The adoption of facial recognition payment across intermediary platforms (Andrejevic & Selwyn, 2020; Elloumi *et al*., 2021; Kostka *et al*., 2021; Seng *et al*., 2021; Yang, 2020) significantly enhances the performance and security of transactions in retail, restaurant, and hotel business models. The facial data of an individual has unalterable invariance, simultaneously constituting exemplary supporting evidence for determining identity information in conformity with dissimilarities between various persons. Third-party machine learning-based payment systems can optimize (Ciftci *et al*., 2021; Lai & Rau, 2021; Liu *et al*., 2021; Moriuchi, 2021; Zhong *et al*., 2021) the efficiency of face-based transactions. Software-based facial recognition tools are a groundbreaking contactless biometric technology. By not necessitating any physical interaction by the customers, facial recognition constitutes the most adequate way of biometric identification in payments. Facial recognition payment has been implemented in both private and public realms for heterogeneous reasons (e.g., setting out physical safety or supplying customized shopping experiences). Having volitional control in relation to adopting facial recognition technology can shape attitudes as regards associated payments in distinction to mandatory usage. Commercially-driven adoption and integration of facial recognition technology cover customer identification, transaction security, smart marketing, and digital payment.

Face biometric authentication (Aljanabi *et al*., 2018; Church, 2018; Feng *et al*., 2017; Palm, 2018; Poole, 2017) relieves mobile customers from memorizing various numeric passwords, in addition to possible disclosure or unrecalled, lost, and illegal access. Facial recognition and fingerprint software provide increased security and surveillance in contrast with alphanumeric identification codes in digital payment.

The processing of payment is more effective (Aljanabi *et al*., 2018; Church, 2018; Feng *et al*., 2017; Palm, 2018; Poole, 2017) than the digital data entry of passcodes. Payments circulate to an increasing extent as subcategories of customized information (Du, 2018; Li *et al*., 2019; Wójtowicz & Chmielewski, 2017; Zhi & Liu, 2019) across the widespread ecosystem of big data. Face recognition may act as a substitute for bar codes in the

near future and is more protected than a credit card. Image similarity and image recognition technologies are significantly harnessed in digital image processing. Biometrics and machine learning can integrate identification and verification procedures (e.g., password and personal identity numbers) to fortify data security in retail, restaurant, and hotel business models (Table 3).

Machine learning algorithms and facial recognition big data systems in retail, restaurant, and hotel sectors

COVID-19 has been pivotal in advancing biometric technologies for payments (Norfolk & O'Regan, 2021; Pantano, 2020; Zhao *et al*., 2020) to recognize and check customers without the risk of physical interaction in retail, restaurant, and hotel business models. Face recognition is extensively deployed in accessing control systems demanding monitoring areas, supervising systems for questionable persons or activities, financial systems for checking customer identity, and paying through biometrics data. Facial expression recognition systems may display customers' assessment of retail service encounters, detect their emotions as regards a particular retail setting, and support employees to significantly grasp users' shopping experience. The growing integration of facial recognition big data systems (Cham *et al*., 2021; Dang *et al*., 2021; Daragmeh *et al*., 2021; De Keyser *et al*., 2021) in retailing may assist employees to in progressively comprehending customers' shopping experience. Machine learning algorithms can be harnessed to systematically appraise retail service encounters by use of customers' facial expressions. Customers are likely to adopt facial expression identification systems that instantaneously assess retail service encounters.

Biometric systems are crucial in differentiating customers by use of their personal data (Levy & Barocas, 2018; Monajemi, 2018), with facial conformation as a biometric identifier, but employing face as a password may raise privacy issues, taking into account the sensitivity of information in facial recognition technologies. Video cameras enable customer tracking and can be optimized by facial detection systems and video analytics that can derive demographic data concerning users. Digital signage (typical touch-sensitive screens linked to a computer and commonly in tandem with a camera and connected sensors) can interact dynamically with in-store moving customers. Users can network without an intermediary with the signs by touching the screen or waving to the camera, and customer data are systematically gathered in real-time. Computer vision can be instrumental in determining user age, gender, race, and emotional disposition/mood

state. Retailers may harness facial recognition technology (Aljanabi *et al*., 2018; Church, 2018; Feng *et al*., 2017; Palm, 2018; Poole, 2017) to identify customers or verify the distinctive identifiers from proximate smartphones. By ascertaining customer identity, retailers can put into practice collected data in customizing signage. Developments in user monitoring and computation can assist in-store signs in surpassing experienced retailers in satisfying the specific interest and choices of customers (Table 4).

Digital image processing and computer vision in software-based facial recognition technology

Facial recognition payment technology, by identifying and configuring feature vectors without the need of physical contact (Kim *et al*., 2019; Liu & Tu, 2021; Zhang & Kang, 2019), is instrumental in optimizing time management, performance, and precision. Even though credit card payment is swift and effortless, misplacing a card or failing to remember the password is possible. As individuals employ uncomplicated passwords and reutilize them on various accounts and services, sharing and cracking them are not uncommon. QR payment is associated with smartphones which can be irretrievable, signals can be intermittent, and batteries can be discharged. Safety, security, transparency, and social representation shape customers' predisposition and perceived usefulness (Ciftci *et al*., 2020; Lau, 2020; Venkatesan *et al*., 2021; Xu *et al*., 2021; Yang *et al*., 2020) to adopt facial recognition payment technology. The volume of effort required impacts the purpose to use facial recognition payment by the mediating determinant of perceived usefulness in retail, restaurant, and hotel business models. Some customers are more partial to cards than to mobile and biometric payments while the level of associated characteristics is similar. Users' positive attitude or resourcefulness in relation to cutting-edge products and services has a relevantly positive impact on options for alternative payments. Preliminary confidence, perceived risk, performance expectation, and company reputation influence considerably customers' behavioral intention to use biometric recognition payment devices.

Biometrics represents the adoption of automated systems (Lott, 2018; Zhang *et al*., 2020) to identify persons according to their biological and behavioral attributes. Technological developments and the integration of sensors into smartphones have enabled biometric capture and analysis to eventually be a chief authentication tool for both physical and remote financial transactions (Andrejevic & Selwyn, 2020; Elloumi *et al*., 2021; Kostka *et al*., 2021; Seng *et al*., 2021; Yang, 2020), fortifying the security

of the payment system in retail, restaurant, and hotel business models. With the all-encompassing leveraging of deep learning operations, categorization and object detection algorithms are now decisive in digital image processing and computer vision. Object detection and image categorization are critical in machine-driven retail applications. Payment is digitally made when customers have finalized shopping and check out from the store, leading thus to remarkably qualitative enhancement in purchasing experience.

Facial features and expressions can provide massive volumes of biometric data (Cham *et al*., 2021; Dang *et al*., 2021; Daragmeh *et al*., 2021; De Keyser *et al*., 2021) to be deployed in diverse business applications in retail, restaurant, and hotel business models. Financial innovative transaction tools and smart payment services decrease time and effort, reconfiguring consumer buying patterns and technological capabilities. Perceived risk, convenience, and ease of use, together with subjective norms, shape consumer perceptual, behavioral, and purchase intentions to adopt contactless payment methods, such as facial recognition and mobile payment services and apps (Kim *et al*., 2019; Liu & Tu, 2021; Lott, 2018; Zhang & Kang, 2019; Zhang *et al*., 2020), particularly during the COVID-19 crisis. The impact of perceived ease of use on behavioral intentions is mediated by perceived convenience. Convenience, ease of use, and innovativeness in terms of perception positively influence, while perceived risk adversely shapes, consumer attitudes in relation to facial recognition payment in retail, restaurant, and hotel business models. Consumer attitudes improve service satisfaction, relationship mediated by hedonic shopping value. Facial recognition payment can optimize hedonic shopping value in addition to consumer satisfaction. Difficulty, disagreement, and cost are perceived functional barriers, absence of trust, inactivity, and technological anxiety are psychological limitations, while privacy, security, financial, and operational risks increase resistance in relation to mobile payment services, and lead to non-adoption intention and stickiness to cash (Table 5).

Privacy and security concerns triggered by use of software-based facial recognition technology

Facial recognition payment assists customers in carrying out transactions in a few seconds (Ciftci *et al*., 2021; Lai & Rau, 2021; Liu *et al*., 2021; Moriuchi, 2021; Zhong *et al*., 2021), resulting in growing service efficiency. Financial incentives and a gratifying user experience may stimulate customers to embrace facial recognition payment in retail, restaurant, and hotel

business models. Supplying adequate technical support and resources enables coherent facial recognition payment. Perceived contentment, ease of use, and convenience, in addition to smooth conditions, personal resourcefulness, coupon accessibility, and attitude shape customers' decisions as regards facial recognition payment. In the preliminary phase of facial recognition payment, customers are inclined to risk their privacy as a compensation for comparable benefits. Some customers are hesitant as regards adopting technology that demands their biometric data, while easing their shopping experience. Determinants that influence customers' confidence in, attitude in relation to, and embracing of a biometric payment system (Levy & Barocas, 2018; Monajemi, 2018; Norfolk & O'Regan, 2021; Pantano, 2020; Zhao *et al*., 2020) indicate that users would rather deploy it in shopping centers than online. Facial recognition payment has been swiftly implemented, together with the likelihood of misutilization as a result of technical obstacles and legal inconsistencies. Performance expectancy, social impact, and confidence shape customers' rationales to use facial recognition technology for loyalty and payment account authorization.

Before putting money into biometric technology (Ciftci *et al*., 2020; Lau, 2020; Venkatesan *et al*., 2021; Xu *et al*., 2021; Yang *et al*., 2020), retail and restaurant management should analyze whether their customers intend to adopt it and what determinants shape their decision. Perceived performance expectancy and security protection, social impact, and confidence in relation to the system constitute predictors of customers' disposition to adopt facial recognition technology in retail and at restaurants. Enabling conditions, in addition to perceived effort expectancy, personal innovativeness as regards data-driven technology, and privacy protection do not impact the purpose to adopt facial recognition payment by retail and restaurant customers. As a consequence of growing attacks in the context of facial recognition algorithms as an identity authentication (Cham *et al*., 2021; Dang *et al*., 2021; Daragmeh *et al*., 2021; De Keyser *et al*., 2021), mobile systems users may be worried in relation to the security of facial recognition modules within their devices. The fusion of 5G technology and machine learning in the retail, restaurant, and hotel sectors may facilitate rapid check-in and transactions by use of facial recognition payment, resulting in significant enhancement in service performance and security. Customer adoption behaviors of innovative technologies integrate facial recognition services in retail, restaurant, and hotel business models as regards trust, security, and privacy. Secure payment systems can be optimized throughout online transaction by facial and proxy detection and recognition algorithms in terms of accuracy and efficiency.

Face recognition is pivotal in gathering biometric data (Du, 2018; Li *et al.*, 2019; Wójtowicz & Chmielewski, 2017; Zhi & Liu, 2019), carrying a massive quantity of personal information characteristics, high identification, and particularity. Face recognition involves image processing, computer programming, artificial intelligence, biological engineering, and neural network. Face recognition algorithms can be thoroughly harnessed to the confirmation of mobile payment in retail, restaurant, and hotel business models. Face recognition technology has swiftly advanced in the sphere of smartphones and control systems (Kim *et al*., 2019; Liu & Tu, 2021; Lott, 2018; Zhang & Kang, 2019; Zhang *et al*., 2020) in terms of face payment applications together with security concerns. Developing sound and trustworthy antispoofing attack detection is essential in ensuring the structural integrity of facial analysis-based validation, especially through deep learning techniques that have attained robust performance in computer vision. The current contactless payment options can be surmounted by automated or authorized payments, non-participative user recognition with ambient facial identification, and smart monitoring of payment security level (Table 6)

Discussion

We integrate our systematic review across recent studies (Aljanabi *et al*., 2018; Ciftci *et al*., 2021; Lai & Rau, 2021; Lau, 2020; Levy & Barocas, 2018; Liu *et al*., 2021; Lott, 2018; Moriuchi, 2021; Palm, 2018; Seng *et al*., 2021; Yang *et al*., 2020; Zhao *et al*., 2020; Zhong *et al*., 2021) indicating that some facial recognition payment tech start-ups require their customers in retail, restaurant, and hotel sectors to set up an account via its website on their smartphone, upload a selfie, stored on the cloud-based system, for their profile, and specify a payment method for a debit/credit card (no other identification or pin number is needed). To pay, customers look into the camera of a small LCD screen, a cashier verifies the entire contactless process, and the money is withdrawn, all in five seconds. To tip, customers can use a hand gesture tipping tool. The digital picture, a mathematical map of distinctive facial vectors, is removed instantly, no location tracking is possible, and the data is not shared.

Our research harmonizes with analyses (Andrejevic & Selwyn, 2020; Church, 2018; Du, 2018; Li *et al*., 2019; Monajemi, 2018; Norfolk & O'Regan, 2021; Poole, 2017; Venkatesan *et al*., 2021; Wójtowicz & Chmielewski, 2017; Yang, 2020; Zhang & Kang, 2019; Zhi & Liu, 2019) elucidating how facial recognition payment systems operate across thou-

sands of locations, sometimes constituting the only digital-payment method to purchase food from vending machines and at physical (e.g., clothing and grocery) stores. A touchscreen device positioned at the checkout counter communicates with the facial data archive. The cashier registers the sum of money for the order that is subsequently displayed on the device screen. The customer presses Pay with Face Recognition lightly on the device screen that scans the physiognomy and identifies the user who following that taps Confirm Payment. A validated account and an integrated bank one are needed.

We clarify, by cumulative evidence, previous papers (Cham *et al*., 2021; Ciftci *et al*., 2020; Dang *et al*., 2021; Daragmeh *et al*., 2021; De Keyser *et al*., 2021; Elloumi *et al*., 2021; Feng *et al*., 2017; Kim *et al*., 2019; Kostka *et al*., 2021; Liu & Tu, 2021; Pantano, 2020; Xu *et al*., 2021; Zhang *et al*., 2020) proving how in some hotels, restaurants, convenience stores, and supermarkets 3D cameras process the faces of individuals who enter (assessing the width, height, and depth of their distinctive features) and scan them a second time at check-out. In light swift transit lines, while passing through an access gate, passengers stare at a screen, and once identified, the transport cost is digitally extracted from a linked account. A mobility and payment app enables them to transfer a selfie and connect it to their preferred payment method.

Conclusions

Relevant research has investigated whether machine learning-based payment systems can optimize the efficiency of face-based transactions, customer adoption behaviors of innovative technologies. Technological developments and the integration of sensors into smartphones have enabled biometric capture and analysis. Facial recognition constitutes the most adequate way of biometric identification in payments by not necessitating any physical interaction by the customers. Software-based facial recognition tools are a groundbreaking contactless biometric technology shaping consumer perceptual, behavioral, and purchase intentions to adopt contactless payment methods.

This systematic literature review presents first-rate published peer-reviewed evidence regarding machine learning algorithms and facial recognition big data systems in retail, restaurant, and hotel sectors. The findings resulted from the above analyses indicate that harnessing facial recognition payment applications as software-based contactless biometric algorithms results in remarkably qualitative enhancement in purchasing experience.

Facial recognition big data systems and mobile payment services and apps enable customer shopping experience tracking.

Limitations, implications, and further directions of research

By covering only original empirical research published in journals indexed in the Web of Science, Scopus, and ProQuest databases between 2017 and 2021, relevant articles on facial recognition biometric authentication as a mobile payment technology in retail business models may have been omitted. Subsequent attention should be directed to whether perceived value and trust shape customers' adoption of biometric recognition payment devices. The scope of our systematic review does not advance how machine learning algorithms can be harnessed to systematically appraise retail service encounters by use of customers' facial expressions. Subsequent analyses should develop on facial detection systems and video analytics in terms of digital image processing and computer vision, deep learning operations, and categorization and object detection algorithms. Future research should investigate how face recognition algorithms and financial innovative transaction tools can be thoroughly harnessed to the confirmation of mobile payment in other sectors than retail, restaurant, and hotel business models.

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Annex

Table 1. Topics and types of paper identified and selected

Topic	Identified	Selected
facial recognition payment technology	52	11
facial recognition payment system	38	8
facial recognition payment application	33	5
face recognition-based payment service	27	5
facial authentication for mobile payment transactions	21	5
contactless payment through facial recognition algorithms	16	4
Type of paper		
original research	143	38
review	8	0
conference proceedings	27	0
book	3	0
editorial	6	0

Note: Some topics overlap.

Table 2. Summary of evidence as regards inspected topics and descriptive outcomes (research findings)

The adoption of facial recognition payment across intermediary platforms significantly enhances the performance and security of transactions in retail, restaurant, and hotel business models.	Andrejevic and Selwyn, 2020; Elloumi *et al.*, 2021; Kostka *et al.*, 2021; Seng *et al.*, 2021; Yang, 2020
Face biometric authentication relieves mobile customers from memorizing various numeric passwords, in addition to possible disclosure or unrecalled, lost, and illegal access.	Aljanabi *et al.*, 2018; Church, 2018; Feng *et al.*, 2017; Palm, 2018; Poole, 2017
COVID-19 has been pivotal in advancing biometric technologies for payments to recognize and check customers without the risk of physical interaction in retail, restaurant, and hotel business models.	Norfolk and O'Regan, 2021; Pantano, 2020; Zhao *et al.*, 2020
Biometric systems are crucial in differentiating customers by use of their personal data, with facial conformation as a biometric identifier, but employing face as a password may raise privacy issues, taking into account the sensitivity of information in facial recognition technologies.	Levy and Barocas, 2018; Monajemi, 2018
Facial recognition payment technology, by identifying and configuring feature vectors without the need of physical contact, is instrumental in optimizing time management, performance, and precision.	Kim *et al.*, 2019; Liu and Tu, 2021; Zhang and Kang, 2019
Biometrics represents the adoption of automated systems to identify persons according to their biological and behavioral attributes.	Lott, 2018; Zhang *et al.*, 2020
Facial features and expressions can provide massive volumes of biometric data to be deployed in diverse business applications in retail, restaurant, and hotel business models.	Cham *et al.*, 2021; Dang *et al.*, 2021; Daragmeh *et al.*, 2021; De Keyser *et al.*, 2021
Facial recognition payment assists customers in carrying out transactions in a few seconds, resulting in growing service efficiency.	Ciftci *et al.*, 2021; Lai and Rau, 2021; Liu *et al.*, 2021; Moriuchi, 2021; Zhong *et al.*, 2021

Table 2. Summary of evidence as regards inspected topics and descriptive outcomes (research findings)

Facial recognition payment assists customers in carrying out transactions in a few seconds, resulting in growing service efficiency.	Ciftci *et al.*, 2021; Lai and Rau, 2021; Liu *et al.*, 2021; Moriuchi, 2021; Zhong *et al.*, 2021
Before putting money into biometric technology, retail and restaurant management should analyze whether their customers intend to adopt it and what determinants shape their decision. Face recognition is pivotal in gathering biometric data, carrying a massive quantity of personal information characteristics, high identification, and particularity.	Ciftci *et al.*, 2020; Lau, 2020; Venkatesan et al., 2021; Xu *et al.*, 2021; Yang *et al.*, 2020 Du, 2018; Li *et al.*, 2019; Wójtowicz and Chmielewski, 2017; Zhi and Liu, 2019

Table 3. Software-based facial recognition tools as a groundbreaking contactless biometric technology for payments

The adoption of facial recognition payment across intermediary platforms significantly enhances the performance and security of transactions in retail, restaurant, and hotel business models.	Andrejevic and Selwyn, 2020; Elloumi *et al.*, 2021; Kostka *et al.*, 2021; Seng *et al.*, 2021; Yang, 2020
Face biometric authentication relieves mobile customers from memorizing various numeric passwords, in addition to possible disclosure or unrecalled, lost, and illegal access.	Aljanabi *et al.*, 2018; Church, 2018; Feng *et al.*, 2017; Palm, 2018; Poole, 2017

Table 4. Machine learning algorithms and facial recognition big data systems in retail, restaurant, and hotel sectors

COVID-19 has been pivotal in advancing biometric technologies for payments to recognize and check customers without the risk of physical interaction in retail, restaurant, and hotel business models.	Norfolk and O'Regan, 2021; Pantano, 2020; Zhao *et al.*, 2020
Biometric systems are crucial in differentiating customers by use of their personal data, with facial conformation as a biometric identifier, but employing face as a password may raise privacy issues, taking into account the sensitivity of information in facial recognition technologies.	Levy and Barocas, 2018; Monajemi, 2018

Table 5. Digital image processing and computer vision in software-based facial recognition technology

Facial recognition payment technology, by identifying and configuring feature vectors without the need of physical contact, is instrumental in optimizing time management, performance, and precision.	Kim *et al.*, 2019; Liu and Tu, 2021; Zhang and Kang, 2019
Biometrics represents the adoption of automated systems to identify persons according to their biological and behavioral attributes.	Lott, 2018; Zhang *et al.*, 2020
Facial features and expressions can provide massive volumes of biometric data to be deployed in diverse business applications in retail, restaurant, and hotel business models.	Cham *et al*., 2021; Dang *et al.*, 2021; Daragmeh *et al*., 2021; De Keyser *et al*., 2021

Table 6. Privacy and security concerns triggered by use of software-based facial recognition technology

Facial recognition payment assists customers in carrying out transactions in a few seconds, resulting in growing service efficiency.	Ciftci *et al.*, 2021; Lai and Rau, 2021; Liu *et al.*, 2021; Moriuchi, 2021; Zhong *et al.*, 2021
Before putting money into biometric technology, retail and restaurant management should analyze whether their customers intend to adopt it and what determinants shape their decision.	Ciftci *et al.*, 2020; Lau, 2020; Venkatesan et al., 2021; Xu *et al.*, 2021; Yang *et al.*, 2020
Face recognition is pivotal in gathering biometric data, carrying a massive quantity of personal information characteristics, high identification, and particularity.	Du, 2018; Li *et al.*, 2019; Wójtowicz and Chmielewski, 2017; Zhi and Liu, 2019

Figure 1. PRISMA flow diagram describing the search results and screening