Applying Biometric Technology for Enhancing Airports' Efficiency: A Technology Acceptance Model as an assessing tool

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ARTICLE INFO

Keywords:
Biometric technology, IATA ID, Technology Acceptance Model (TAM).

(IJTHS), O6U

Vol. 3, No. 2, October 2022,
pp. 104- 117

Abstract

After covid-19 pandemic, airlines-imposed restrictions to eliminate the spread of pandemic. In addition, they permitted applying some automated processes to reduce number of traveler touchpoints during the travel process. From this perspective, the importance of applying biometric technology at airports has been appeared as it provides a contactless method of identity verification as it enables travelers to rapidly finish their journey procedures. In addition, it enables governments to detect deceitful travel documents, visa overstays, security threats and diseases. There is limited research engaging the importance of applying biometric technology to eliminating covid-19 pandemic. This paper aims at assessing travelers' viewpoints regarding applying biometric technology at Egyptian airports. The study adopted technology acceptance model (TAM) to predict travelers' viewpoints. A survey of 350 questionnaires distributed among Egyptian and foreigner travelers from various nationalities who usually travel through Egyptian airports has been taken place from March 2022 till September 2022 within different destinations (i.e., Cairo, Hurghada) with a 95.7% tourist responsive rate. Descriptive analysis has been conducted by IBM SPSS 26. The study recommended the necessity of applying a single biometric token and IATA ID for domestic as well as international flights and being more globally used between airports of various destinations.

Introduction

The current covid-19 pandemic has forced aviation industry to regulate patterns applied at airports to adapt the situation. With the decrease of passenger demand, governments exert efforts to survive the crisis. The international air transport association (IATA) stated that every government has to financially support the aviation sector through direct financial support, tax relief and loans as the recovery of aviation industry will take place after passing the critical period of covid-19 outbreak (IATA,2020). Traveler identification is a critical area that lacks advanced techniques in the aviation industry so implementing new strategies is necessary to overcome covid-19 losses in aviation industry.

Stakeholders of air transportation face a critical challenge as the aviation industry forecasts a remarkable increase of air traveler traffic over the next 20 years while airport capacity will not be able to accommodate especially during covid-19 pandemic. In addition, recent technological innovations have raised travelers' expectations for a smooth, peaceful, efficient and specialized journey. From this perspective, applying automation through self-service facilities come as an urgent need. In that sense, IATA is cooperating with air transport stakeholders to apply its one ID initiative to provide travelers with the experience they need and to avoid airport congestion. One ID is helping to accelerate travel procedures through using a single biometric travel token (i.e., fingerprints, face scan, iris scan) where traveler's information is provided directly to governments without intermediates. (IATA,2022).

The goal of this study is to emphasize ensuring regulations of contactless travel as biometric technology will make travel process more efficient and pleasant to travelers. Moreover, it will protect them from the pandemic infection, it will depend on self-service for travelers, enhance airport efficiency and saving costs for stakeholders. The study adopted technology acceptance model (TAM) which is widely used to measure consumer's acceptance behavior (Ma &Liu,2005). Although many models have been used to predict consumer's acceptance of technology, the TAM has been the only one which captured the attention of information technology community (Chuttur,2009).

The importance of this study stems from the necessity of applying biometric technology in times of pandemic to decrease traveler touchpoints. The study shed light into the importance of applying a single biometric token that includes traveler identification which facilitate travel procedures through scanning face, fingerprints, iris and retina. Applying biometrics will shorten time to traveler from curb to gate. In addition, it will allow governments to avoid passport imitation and border-criminal processes.

1.Literature review

1.1. Covid-19 pandemic

The explosion of covid-19 has become one of the hardest global health crises which negatively affected GDP growth as 65.5 million jobs around the world are supported by aviation industry. In addition,36.7 million jobs are related to tourism sector where air transport has a crucial role in carrying travelers and goods between destinations (ATAG,2020). furthermore, over 2.7 million airline jobs are in risk as many airlines had to stop flying due to the remarkable decrease of passenger demand (IATA,2020). In response to the crisis, many airports closed parts of infrastructure and re-evaluated the airport expenses to decrease the cost to the minimum amount and handle the financial situation (Serrano &Kazda,2020).

The requirement of ensuring physical distancing is necessary during covid-19 pandemic as ramping -up of passengers will help to spread the disease especially number of passenger flow can't be predictable. This process of physical distancing will take place through: 1. queue areas for check -in process, security and other operational areas within the airport ,2. Occupancy of terminal areas including gate hold lounges, baggage reclaims area, toilets. In addition, cleaning aircrafts and terminal areas and depending on personal protective equipment (PPE) for staff are necessary to overcome the crisis. (Hounsgoard &Don,2020)

According to Serrano and Kezda (2020), it will take a long time for airports to recover from covid-19 pandemic so applying self -service and contactless technologies will transcend the crisis. Moreover, they assured that technology will reduce operational cost, improve passenger experiences and minimize the spread of covid-19 pandemic.

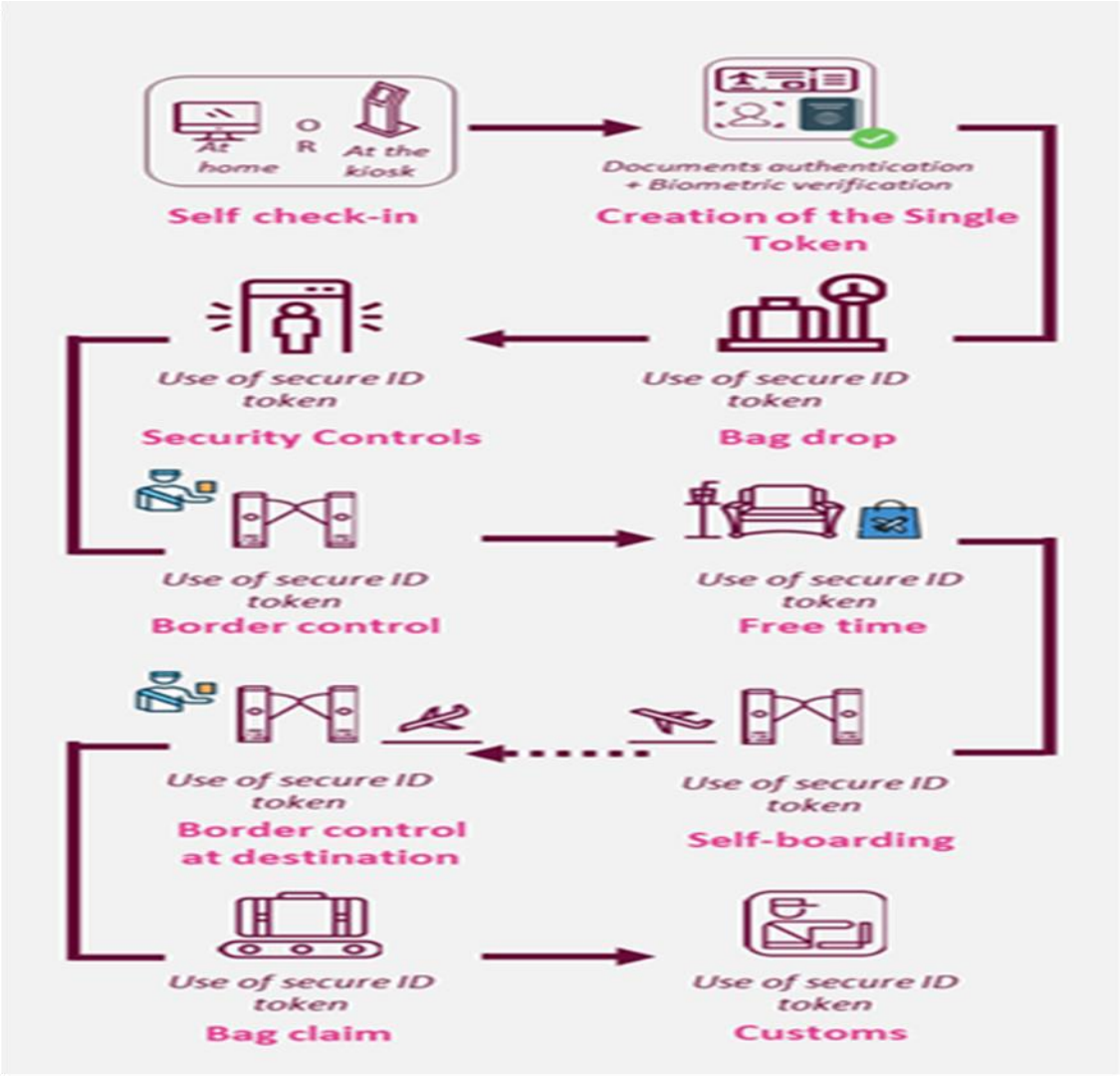
1.2. Biometric technology

Biometric technology is defined as the automated apply of physiological or behavioral features for the verification of traveler's identity. In addition, it has been thought to be an implementation of pattern recognition algorithms to identify humans through analyzing and synthesizing (Wang & Yanushkevich ,2014;Miltgen et al.,2013). Implementing biometric technology is a crucial step in managing aviation industry in times of covid-19 crisis as it includes (facial /fingerprints / iris recognition). Applying biometric technology will reduce contact between passengers at all touchpoints (i.e., check-in, baggage drop off area, border and boarding area) which, in turn, will contribute to minimize the spread of covid-19 pandemic (Serrano &Kezda,2020).

Biometric technology enables passengers to proceed all stages of their journey. In addition, it enables replacing all forms of travel documentations for self-identification and authenticity. using **biometric self-service facilities** will verify passenger's identity at all touchpoints (check in, bag drop off area, border areas, boarding) without the need to use any documents. The traveler biometric characteristics (iris, face, or fingerprints) will be created at the first touchpoint (i.e., at check in area) or through a "selfie" shot on a devoted mobile application. At this stage called the registration process, the passenger's **digital biometrics** are captured, stored on a secure platform, and attached **with the passenger's travel documents** to create a **"single token"** which will be used to identify the passenger during finishing travel procedures. The passenger digital record will be stored at a platform designed with privacy principle. Moreover, only the passenger and the government have access to it while finishing travel procedures as biometric record is continual and doesn't need to be repeated for every journey (Sia partners,2018). **The secure ID token for a passenger** will facilitate journey procedures during check in process, security controls, bag dropping, border control, rest areas, border control within a destination, self- boarding, bag claiming and customs (Figure:1).

Biometric technology is applied to create traveler identity involving the face authentication, fingerprint, iris authentication, palm authentication, voice and signature. In addition, there are four aspects of biometrics which are; 1. **universality**: as every traveler has his unique characteristics ,2. **distinctiveness**: travelers have various characteristics ,3. **existence**: these characteristics should be existed for a period of time and 4. **countability**: these characteristics could be quantitively measured. Furthermore, biometrics notably affect traveler's satisfaction of a destination when using biometric passports and finishing journey procedures rapidly with

keeping traveler's information safe and under government's control, travelers will be satisfied and loyal to a destination (Neo et al.,2014).



(Figure :1) Applying biometric technology at airports
(Source: Sia partners,2018)

1.3. Biometric data analysis and pattern recognition

The multi-biometric approach employed in a biometric system is used to measure physiological or behavioral traits through; **Direct biometrics** which refer to the traditional human recognition methods which depend on analysis and synthesis. In addition, it includes

1. **fingerprint identification** which is a broadly developed biometric sensor ,
2. **Signature analysis** which has been used after the development of human computer interaction devices that allow inputting handwriting and signatures ,
3. **Face identification system** which detect shapes and details of the face and perform facial identification process which includes tracking ,detecting , analysis and synthesis,

4. **iris identification** system which scans the surface area of the iris to compare tissues and organs .in addition, it's considered the most applied one ,
5. 5.**Retina identification** system which scans the surface area of retina and compare nerve tissues and vessels (Wang &Yanushkevich,2014,Neo et al.,2014).

Other biometrics which include untraditional biometric methods for human recognition which involves ,

1. **Gait biometrics** which includes traveler's identification through the style of walking,
2. **ear identification ,**
3. **Odour identification ,**
4. **keystroke identification (** Ross et al.,2006).Furthermore, The most applied biometric technologies for travelers' identification are; face identification, fingerprints, iris identification, palm geometry, and voice identification (Shaikh &Rabaiotti,2010).

1.4. IATA One ID

One ID enables travelers to regulate their travel procedures through a biometric identification management process. Travelers will be able to identify themselves at each airport touchpoint through biometric identification technology. In addition, the purpose of this ID is to create collaboration between all stakeholders (i.e., travelers, airports/airlines and governments) (Table:1).(IATA,2022).

Table (1) Benefits of applying IATA One ID

Stakeholders	Benefits of applying IATA One ID
Travelers	1.improving the overall traveler experience 2.sharing digital identity with airlines, airports and governments 3.eliminating repetitive processes and saving time
Airlines, Airports	1.improving staff productivity 2.reducing time spent on checking manual ID 3.allowing smart queuing to travelers 4.optimizing airport space efficiency 5.winning travelers' satisfaction and delighting
Governments	1.strengthening border security 2.receiving accurate passenger information including their biometrics 3.preventing cross-border criminal activities and passport imitation

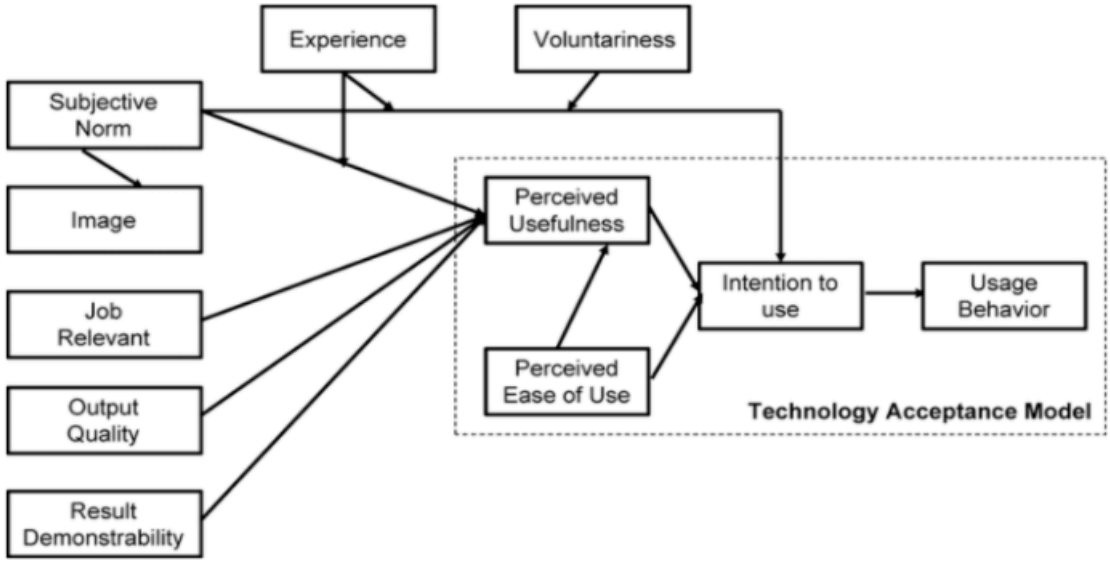
(Source: Own elaboration)

1.5. Technology Acceptance Model (TAM)

After the spread of applying information technology (IT), various models have been proposed to measure consumer's acceptance behavior. Technology Acceptance Model (TAM) has been proposed by Davis (1986) to perceive ease and usefulness while applying information technology and predict consumer's acceptance (Ma and Liu ,2005) as it was based on the Theory of Reasoned Action (TRA) which demonstrated that beliefs affect attitudes which, in turn, lead to decisions and affect traveler behavior (Fishbein &Azjen,1975).The (TRA) demonstrated that customer's behavior can be determined by recognizing his/her primary intention and his/her beliefs regarding this behavior. Moreover, it stated that behavioral intention can be determined through considering the attitude that a customer has towards the actual behavior and the personal norm associated with a behavior (Chuttur,2009).

Understanding the technology acceptance model is an essential step for applying technology especially at airports (Chuttur,2009). According to (Davis,1989; Miltgen et al.,2013;Venkatesh and Bala,2008;Jaradat,2014), technology acceptance model is consisted of three main elements which are; perceived usefulness (PU) which is defined as the degree to which a customer believes that applying a new pattern of technology will improve efficiency, perceived ease of use (PEOU) which is defined as the degree in which a customer believes that applying a new pattern of technology won't demand any additional efforts and behavioral intention to use (BITU) which means the degree to which the customer's motivations intend to apply a new pattern of technology. In addition, they stated that (PU) and (PEOU) have a remarkable effect on consumer's beliefs and predict his/her attitude and acceptance of applying technology.

Davis (1985) stated that customer's attitude towards a system was a major determinant of whether the customer will accept or refuse the system and he outlined that attitude was influenced by two beliefs (i.e., perceived usefulness and perceived ease of use).Sanchez-franco (2010) has used (TAM) to identify learning effectiveness by applying information technology as an online learning platform and he indicated that perceived usefulness, perceived ease of use have a remarkable role in predicting students' intention and their acceptance of applying technology in the learning process. According to Liao et al, (2018), technology acceptance model can be applied to illustrate individual's willingness to accept a web-based assessment system.



(Figure:2) Social variables that affect Technology Acceptance Model
Source:(Venkatesh and Bala,2008)

According to(figure:2), applying a new pattern of technology requires identifying social influence and cognitive measures (i.e., subjective norm which affects individual's perceptions towards applying technology, image which is a measurement of system efficiency, job relevance which states that applying technology is relevant to individual's work, output quality which refers to the efficiency of performing technology, and result demonstrability which states that results are tangible and observable). In addition, conducting surveys is necessary to measure perceived usefulness, perceived ease of use and the intention to use (Venkatesh and Bala,2008; Jarad,2014).

2.Study Hypotheses

The study adopted (TAM) to assess travelers' viewpoints about applying biometric technology at Egyptian airports. The study hypotheses have been established from factors of (TAM) model;

H1: Perceived ease of use biometric technology positively affects its perceived usefulness
H2: Perceived ease of use biometric technology positively affects behavioral intention to use
H3: Perceived usefulness of biometric technology positively affects behavioral intention to use.
H4: Perceived fears of biometric technology negatively affects behavioral intention to use.

3.Methodology

3.1. Data collection:

A quantitative survey of 350 questionnaires distributed among tourists from various nationalities, who usually travel through Egyptian airports, from March 2022 till September 2022 to investigate their viewpoints about applying biometric technology at Egyptian airports to increase their efficiency especially in times of covid 19 crisis. In addition, it was translated to different languages (i.e. Arabic, English, German, French) to facilitate being perceived by various tourists from different nationalities. The questionnaire was sectioned into four parts depending on (TAM) to assess tourists' acceptance of applying biometric technology at Egyptian airports. A five-point Likert scale with 1 indicating strongly disagree, and 5 strongly agree was used.

The questionnaires were self-report via the drop-off and collect method within different destinations (i.e., Cairo, Hurghada), sending e-mails and a google form distributed online among various tourists (i.e., Egyptians ,German ,French ,U.S.A.,etc). The most responsive travelers were Egyptians who encouraged the idea of implementing biometric technology at Egyptian airports for efficiency ramifications.

3.2. Data analysis and findings

The study depended on distributing 350 questionnaires among various tourists and about 316 questionnaires were suitable for analysis which refers to a tourist responsive rate about 95.7%. Descriptive analysis has been performed by IBM SPSS 26; The reliability conducted by Cronbach's alpha. Frequencies and percentages were used to categorize demographic variable, Means, standard deviation (table:2)

3.2.1. Reliability analysis

Table (2) Cronbach's alpha analysis

Study variables	Items num.	Cronbach's alpha
Perceived Ease of Use (PEOU)	8	0.87
Perceived Usefulness (PU)	10	0.94
Perceived Fears (PF)	6	0.93
Behavioral intention to use (BITU)	48	0.81

Table (2) illustrates Cronbach's alpha analysis of study variables which ranges from 0.81 to 0.94 and it refers to a strong consistency between items of study variables.

3.2.2. Descriptive analysis

3.2.2.1. perceived ease of use (PEOU) variable

Table (3) Travelers' viewpoints about (PEOU) biometric technology at airports

PEOU	Mean	St. Deviation
At Entry and departure points	4.32	0.88
At Boarding points	4.55	0.92
At Customs area	4.03	0.98
At VIP area	4.70	0.60
At Checking airline tickets area	3.75	1.12
At personal identity verification area	4.65	0.87
At Baggage claiming area	4.27	1.00
Through Financial dealings	3.88	0.90

Table (3) indicates travelers' viewpoints regarding (PEOU) biometrics at Egyptian airports. The value of mean ranges between 4.03 and 4.80 which illustrates the sample acceptance of applying biometrics at entry and departure points (4.32), boarding points (4.55), customs area (4.03), VIP area (4.70), checking airline ticket area (3.75), personal identity verification area (4.65), baggage claiming area (4.27) and through financial dealings (3.88). The various values of standard deviation confirm the dispersion in the opinions of the study sample.

3.2.2.2. Perceived Usefulness variable

Table (4) Travelers' viewpoints about (PU) of applying biometric technology

(PU)	Mean	St. Deviation
Enhancing safety and security	4.86	0.65
Avoiding terrorism	4.73	0.74
Border protection	3.40	1.01
Avoiding pandemic spread	3.77	0.99
Saving time and preventing long queuing	3.50	1.22
Avoiding luggage loss	4.00	0.83
Enhancing customs area	3.44	0.91
Achieving traveler satisfaction	4.42	1.05
Achieving traveler loyalty	4.27	1.00
Raising destination's competitiveness	4.21	0.94

Table (4) indicates travelers' viewpoints regarding perceived usefulness (PU) of applying biometric technology at Egyptian airports The mean's value ranges from 3.40 to 4.86 which illustrates perceived usefulness of applying biometric technology as it will contribute to enhancing safety and security (4.86), avoiding terrorism (4.73), border protection (3.40), avoiding pandemic spread (3.77),saving time and preventing long queuing (3.50),avoiding luggage loss (4.00),enhancing customs area (3.44),achieving traveler satisfaction (4.42),achieving traveler loyalty (4.27) and raising destination's competitiveness (4.21). The various values of standard deviation confirm the dispersion in the opinions of the study sample.

3.2.2.3. Perceived Fears (PF) variable

Table (5) Travelers' viewpoints about (PF) of applying biometric technology

(PF)	Mean	St. deviation
Privacy violation	3.15	0.83
Harmful health effects	1.42	1.13
Absence of legislations	3.01	0.99
Difficulties in applying biometrics	4.70	0.60
Lack of awareness	4.02	0.98
Lack of trained staff to help travelers	3.22	0.67

Table (5) indicates travelers' viewpoints regarding perceived fears of applying biometric technology at Egyptian airports .The mean's value ranges from 1.42 to 4.70 which illustrates the sample's fear of applying biometric technology regarding privacy violation (3.15), harmful health effects (1.42),the absence of legislations which control biometric use (3.01),difficulties in applying biometrics (4.70) especially those who have lack of experience in dealing with technology ,lack of awareness(4.02) and lack of trained staff to help travelers (3.22). The various values of standard deviation confirm the dispersion in the opinions of the study sample.

3.2.2.4. Behavioral Intention to Use (BITU) variable

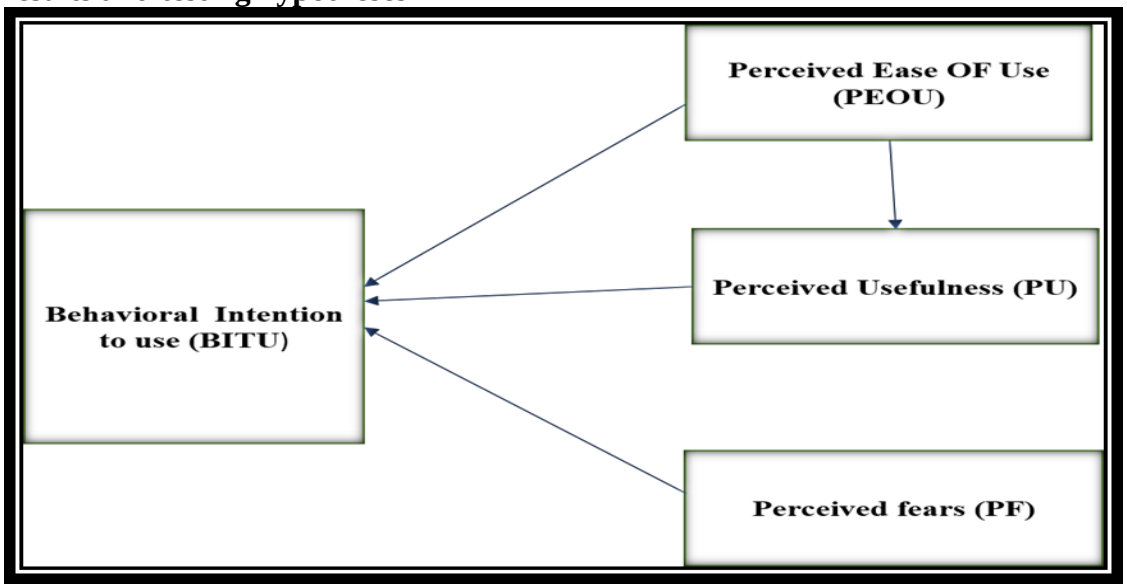
Table (6) Travelers' viewpoints about (BITU) biometric technology at airports

(BITU)	Mean	St. Deviation
Entry and departure points		
Fingerprint identification	3.90	0.98
Iris identification	1.28	0.92
Retina identification	1.19	1.06
Face identification	1.51	0.86
palm geometry	1.70	1.21
Signature	2.61	1.14
Financial Dealings		
Fingerprint identification	1.26	0.83
Iris identification	1.67	0.69
Retina identification	1.35	0.75
Face identification	2.24	1.15
palm geometry	2.33	1.03
Signature	1.28	0.99
Personal Identity verification		
Fingerprint identification	2.03	1.16
Iris identification	1.12	1.22
Retina identification	1.22	0.69
Face identification	3.36	0.76
palm geometry	2.24	1.15
Signature	2.33	1.03

(BITU)	Mean	St. Deviation
VIP area		
Fingerprint identification	4.00	0.91
Iris identification	1.01	0.98
Retina identification	1.82	0.86
Face identification	1.55	1.23
palm geometry	1.93	1.11
Signature	3.88	0.84
Boarding points		
Fingerprint identification	1.16	0.90
Iris identification	1.87	0.88
Retina identification	1.19	0.92
Face identification	2.21	1.20
palm geometry	2.80	0.85
Signature	1.36	0.91
Baggage claiming area		
Fingerprint identification	3.43	1.22
Iris identification	1.87	0.87
Retina identification	1.10	1.01
Face identification	3.70	1.20
palm geometry	3.44	0.79
Signature	3.43	0.67
Customs area		
Fingerprint identification	2.86	0.88
Iris identification	1.22	0.92
Retina identification	1.10	1.02
Face identification	3.86	0.83
palm geometry	3.77	0.91
Signature	3.88	0.67
Checking airline tickets area		
Fingerprint identification	3.87	0.88
Iris identification	1.19	0.92
Retina identification	1.21	1.20
Face identification	2.80	0.85
palm geometry	1.36	0.91
Signature	2.50	0.89

Table (7) indicates travelers' behavioral intention to use biometric technology. The mean's value varies between various uses of biometrics depending on various patterns of applying biometric technology (i.e., fingerprint identification, iris identification, retain identification, face identification, palm geometry, signature). The various values of standard deviation confirm the dispersion in the opinions of the study sample.

3. Results and testing hypotheses



1.Results illustrated that (PEOU) of biometric technology has a positive effect on (PU) as (R=0.78, B=0.63, T= 8.53, P=0.00). This is consistent with (Lim,2001) who clarified that PEOU has a significant impact on PU and he found that its impact is stronger than that on technology acceptance (TA). This confirms the first hypothesis;

H1: Perceived ease of use biometric technology positively affects its perceived usefulness.

2.Results illustrated that (PEOU) of biometrics has a positive effect on (BITU) as (R=0.81, B=0.67 ,T=9.79 ,P= 0.00) .This is consistent with (Morosan,2012;Kim et al.,2010 and Deane et al.,1995) who confirmed that traveler-oriented biometric systems will contribute to raise safety and security and facilitate financial operations during the journey .In addition, they referred to the importance of managing privacy and traveler identification .This confirms the second hypothesis;

H2: Perceived ease of use biometric technology positively affects behavioral intention to use.

3.Results illustrated that (PU) of biometrics has a positive effect on (BITU) as (R=0.83 ,B=0.75 ,T=26.88 ,P=0.00) . This is consistent with Miltgen et al., (2013) who assured that augmented interest of applying biometric technology is fueled by reducing technology costs, system technician quality and political pressure for safety ramifications. This confirms the third hypothesis;

H3: Perceived usefulness of biometric technology positively affects behavioral intention to use.

4.Results illustrated that (PF) of biometric technology negatively affects (BITU) as (R= -.70, B= -0.59, T= -11.19, p= 0.00). This is consistent with Miltgen et al., (2013) who clarified that travelers' fears from applying biometric technology keep them hesitant, uncomfortable and negatively affect biometric technology implementation. In addition, some researchers discovered that travelers have fearful feelings towards applying iris and retina cognition as it may harm their eyes (Neo,2014). The fourth hypothesis has been achieved;

H4; Perceived fears of biometric technology negatively affects behavioral intention to use.

4.Recommendations

Applying biometric technology at Egyptian airports became an urgent step to enhance Egyptian destination's competitiveness. The recommendations of this study will be directed to destination management organizations (DMOs) in Egyptian destination as they should put these procedures in the spotlight;

1. Applying biometric-recognition technology system at airports especially at entry points, baggage claiming area, customs area, VIP area, boarding area, airline tickets checking area and financial dealings area.
2. Hiring experts to provide employees with courses to facilitate the use of biometric technology at airports
3. Applying fingerprinting recognition technology system at airports
4. Applying iris recognition technology system in urgent cases
5. Applying hand geometry technology system at airports
6. Applying voice recognition technology system at airports
7. Applying face recognition technology system at airports
8. Applying signature recognition technology system at airports
9. Providing Staff with courses to help travelers while their biometric recognition process
10. Providing airports with sign boards to help travelers while applying biometrics
11. Launching indoor and outdoor promotional campaigns to spread awareness about applying biometric technology at airports
12. Protecting biometric-system from getting hacked
13. Following-up the maintenance of biometric -system.

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تطبيق تكنولوجيا البيومتريك لرفع كفاءه المطارات المصرية باستخدام نموذج (TAM) كأداه لقياس اراء المسافرين

الملخص باللغة العربية

قامت شركات الطيران بفرض قواعد صارمة للتقليل من انتشار وباء كورونا، كما أنهم اعتمدوا على استخدام التكنولوجيا الحديثة للتقليل من التلامس وانتشار العدوى لذلك زادت أهمية تطبيق تكنولوجيا البيوميتريك فى المطارات لتحديد هوية المسافرين والتحقق من بياناتهم الشخصية وإتمام مراحل سفرهم بسهولة مع التقليل من الازدحام والحفاظ على التباعد بين المسافرين. تعتبر تكنولوجيا البيوميتريك ذات أهمية للتحقق من وثائق السفر المزيفة والفيزا منتهية الصلاحية وتقليل انتشار الأمراض وتجنب التهديدات الأمنية. وعلى الرغم من أهمية تطبيق هذه التكنولوجيا إلا أنه يوجد عدد قليل من الأبحاث التى تناولت تطبيقها فى المطارات، لذلك يهدف هذا البحث إلى تقييم آراء المسافرين عن تطبيق تكنولوجيا البيوميتريك فى المطارات المصرية من خلال توزيع 350 استمارة استقصاء على المسافرين من مختلف الجنسيات والذين اعتادوا على السفر من خلال المطارات المصرية وذلك فى الفترة من 22 مارس حتى 22 سبتمبر لعام 2022 في محافظتي القاهرة والغردقة.

أوصت الدراسه بضرورة تطبيق تكنولوجيا البيوميتريك للرحلات الداخلية والدولية في مختلف المطارات للمقاصد السياحية.

الكلمات الدالة: تكنولوجيا البيوميتريك، المطارات المصرية، نموذج قياس آراء المسافرين.