

Understanding Facial Recognition System Usage and Adaptation among Millennial and Non-millennial consumers



SaurajitMallick, Palak Sharma, Abhishek Srivastava

Abstract: Facial recognition technology has proved its immense usefulness by being one of the most effective and non-intrusive means of authentication system. Privacy concerns are accompanying the development of the facial recognition system since its inception. However, the perception has changed remarkably over the last 6 decades. Rather than considering a facial recognition system as a part of a sci-fi imagination, it has become more realistic and brought convenience, safety, and security to our daily lives. Not only has the millennial, the understanding and adaptation rate of facial recognition system amongst all generations, through mobile devices, Governmental and private projects, reached a significant level. Apart from technical applications, facial recognition provides extensive opportunities in numerous other fields of business. The rate of cooperativeness for innovative usage of facial recognition system seems to rise amongst all the individuals, irrespective their age group. One of the biggest motivators being the self-interests in keeping up with technological advancement, which provides a great opportunity for the marketers and technology companies to provide relevant information for their target audience. This research will try to validate the theory proposed by Murray (2011) that millennial are most comfortable people to adaptation of technology, including the facial recognition system. It also tries to identify the usage and adaptation factors among all the age groups and to find out key business areas where facial recognition can be value addition.

Objective: This paper elaborates the adoption of Facial Recognition System as device access and security enabling technology amongst millennial and non-millennial users. As the technology has seen rising adoption by Government, Business and Individual users; this study attempts to understand customer awareness about the technology as well as perceived challenges and benefits by users. User age group and generation have been used as an indicative parameter to determine if the technology adoption has seen some definitive preference by any one user group.

Design/ Methodology/ Approach: This study entailed a secondary study about customer adoption of Facial recognition systems, followed by a questionnaire-based survey with a mixed population comprising of millennial and non-millennial respondents.

Findings: Through this research work, we could conclude that the millennial age group shown the highest percentage of affinity toward adopting highly advanced technology.

Facial recognition system would be a very effective piece of technology which could enhance the security, safety, and ease of accessibility in various fields. There is a tremendous opportunity for marketers to get benefitted out of this trend. Various measures can be taken to attract millennial and centennial. Though, the older generations showed a positive mindset toward adopting high-tech devices.

One of the greatest motivational factors for purchasing a high-tech device, the researchers have identified, is the self-awareness to find more about the technology. People are more willing to do their research and hands-on experience to know technology better, than relying on other's opinion about the technology. **Practical Implications:** Understanding the adoption challenges about Facial recognition system and the motivating factors that can encourage customers to adopt, can help industries incorporate this technology in devices meant for business and personal use. Although this technology has vast application in security, surveillance and personal device management; this study can help manufacturers develop deeper insight into the positioning of the technology as a benefit desired by the end-users. **Originality & Value:** This paper has attempted to look at the challenges in facial recognition technology adoption from the age-based generation perspective. With increasing millennial users adopting mobile devices with facial recognition feature, the study has attempted to study the appeal of the technology to the millennial generation and the potential lack of appeal for the older generations.

Key words: Facial Recognition system, mobile devices, millennial, non-millennial, security, ease of use, adaptationbehaviour

I. INTRODUCTION:

Global technology space, when it comes to the device security, network or facility access and data management, has evolved progressively to avoid invasion and corruption. Governments and Mega-Corporations have invested billions of dollars in research and development to perfect means for the device, network, data and facility security. Facial recognition system has emerged as a feasible solution in this field and has been in various stages of application since the 1960s. The facial recognition system is a non-contact mode of biometric authentication technique, facial recognition is widely used in environments where the crowd is huge and manual intervention is not possible or rather not viable. This technology is further enhancing the use of Close Circuit Television (CCTV) at critical places, by enabling effective individual recognition, based on scientific data points. In this study, the application and adoption of facial recognition system by the end consumers through various mobile devices are determined and discussed in context with their adaptation, usage,

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* Correspondence Author

Palak Sharma*, Associate Professor, Marketing, Pune Institute of Business Management,

SaurajitMallick, Assistant Professor, Operations, Pune Institute of Business Management, Gut-605/1, Lavasa Road, Pirangut, Pune, Maharashtra, India, 412115.

Abhishek Srivastava, Associate Professor, Economics, Pune Institute of Business Management,

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convenience, safety, and security measures for various generations. Mobile devices are referred to as smartphones with facial recognition capabilities, laptops, tablets, etc.

II. LITERATURE REVIEW:

An introduction of the Facial Recognition System

A facial recognition system is a technology which is capable of identifying a person's face from a video, image, or by matching a database of images with a real individual (Wechsler et al; 2012). A facial recognition system is one of the methods of the biometric identification system. Other biometric systems are fingerprint and iris recognition. If we compare the ease of usage, we will find that the facial recognition system may work on a fully contactless environment. Which indicates that to create a primary database of an individual, one need not touch or wear a device. At the same time, it is also true even a photograph or video of an individual is enough to create the database. Over the years, the functionality of the facial recognition system regarding the accuracy, speed, and dependency has been improved. However, for obvious reasons, the facial recognition system cannot be regarded as the best identification system. One of the crucial reason is, it can be tricked using a high-quality image, mask, makeup etc. (Perekalin, 2018). Fingerprints and iris are unique in the pattern for every single individual. An identification system based on them is more accurate and trustworthy than facial recognition. However, they need individual submission of a sample for the identification. It will consume a lot of time, slowing down the other operations. Let's take an example of the IGI Airport in Delhi. Annually, a total of 69 million people travel through this airport. Which means, in a single day 0.18 million people travel through the IGI airport. Which means, in every hour, 7,900 additional people are joining the crowd. We consider that there are 20 entrances at the airport, and each traveller requires 30 seconds to complete the biometric identification. Which indicates that on an average, a traveller will be spending 3 hours more at the airport. It is an inconvenience for the traveller and additional burden and cost for the airport authority as well. Alternatively, optimization of the CCTV cameras so that they can recognise a traveller as soon as one arrives at the entrance is a real game-changer. In this process, a traveller does not need to halt for an identification check. However, to make the facial recognition system to be this effective, it needs to have highly advanced hardware and software. It leads us to the second part of our discussion, the

functionality of the facial recognition system. The real progress in facial recognition system was achieved with the introduction of the Convolutional Neural Networks (CNNs). CNNs are largely similar to the normal neural network, however, the inputs here are considered as images. Before the introduction of the CNNs, the accuracy rate of the facial recognition system was limited to 90%, which increased to almost as of the human level by the usage of CNNs. In some instances facial recognition system was even able to surpass the human capabilities in recognizing faces. At the same time CNNs proved very beneficial when it comes to detect faces from a large gathering of people (Thakur, 2019).

A brief history of facial recognition system:

In 1960, Bledsoe, Helen, and Bisson started working on projects to make a computer identify a face. The project was funded by a secret organisation and significant details were not found about this research. Apart from a few fundamental details most of the research work is still kept in dark.

In the 1970s era, Goldstein, Harmon, and Lesk introduced 21 facial markers for better identification of a face. Some of these markers are hair colour, the thickness of lips, etc.

In the later part of 1980, Sirovich and Kirby introduce applied linear algebra in the facial recognition system (Eigenfaces approach). Linear algebra was responsible for the creation of a low dimension image profile for a face.

In the early 1990s, Turk and Pentland had brought modifications to improve the Eigenfaces approach. Later a successful case was registered for automated facial recognition system. Face Recognition Technology (FERET) was officially launched. In 2001, Superbowl XXXV was the first events that implemented a massive facial recognition system. The event was to identify criminals amongst normal citizens. In 2009, law enforcement agencies and the Department of Motor Vehicle incorporated facial recognition system. In 2011, Panama International Airport implemented facial recognition based identification system. Facebook and other social media and Amazon introduced a few of the deep learning and neural network-based facial recognition programmes. In 2017, Apple launched a facial recognition system in iPhone X with 3D image capturing capabilities. KFC in China introduced facial recognition-based menu display and a smile-to-pay option for payment. In 2018, Hotel Marriott in China had introduced facial recognition-based guest check-in and key disposal system.

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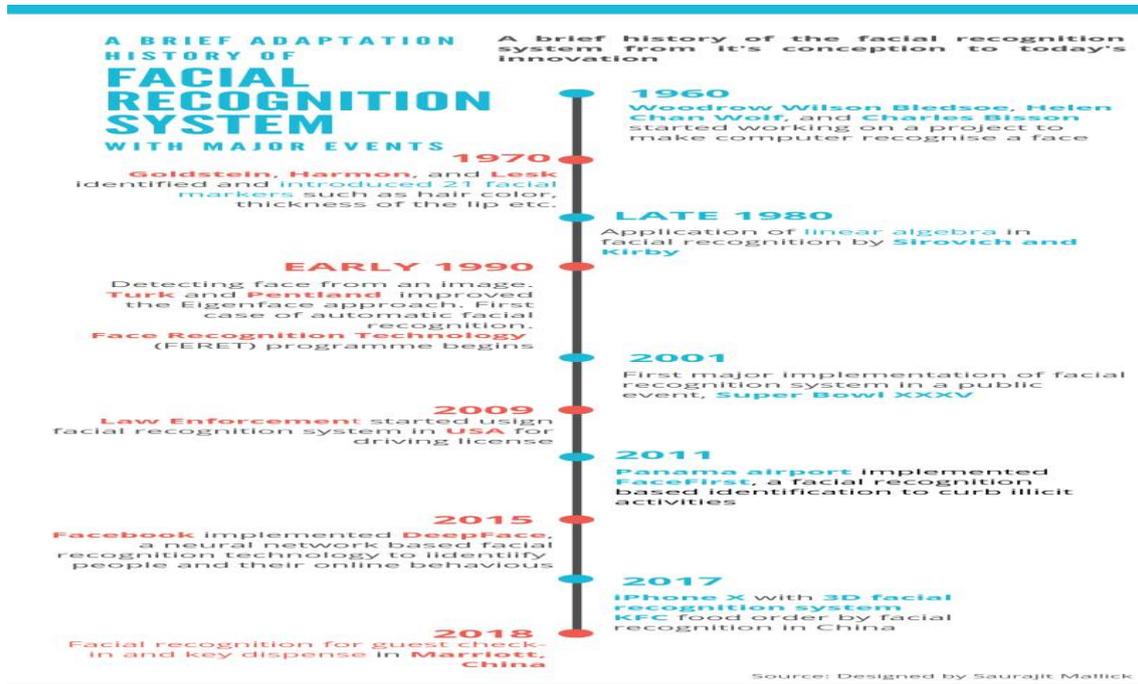


Figure 1: A brief history of facial recognition system, its adaptation, and major events

The functionalities of the Facial Recognition System

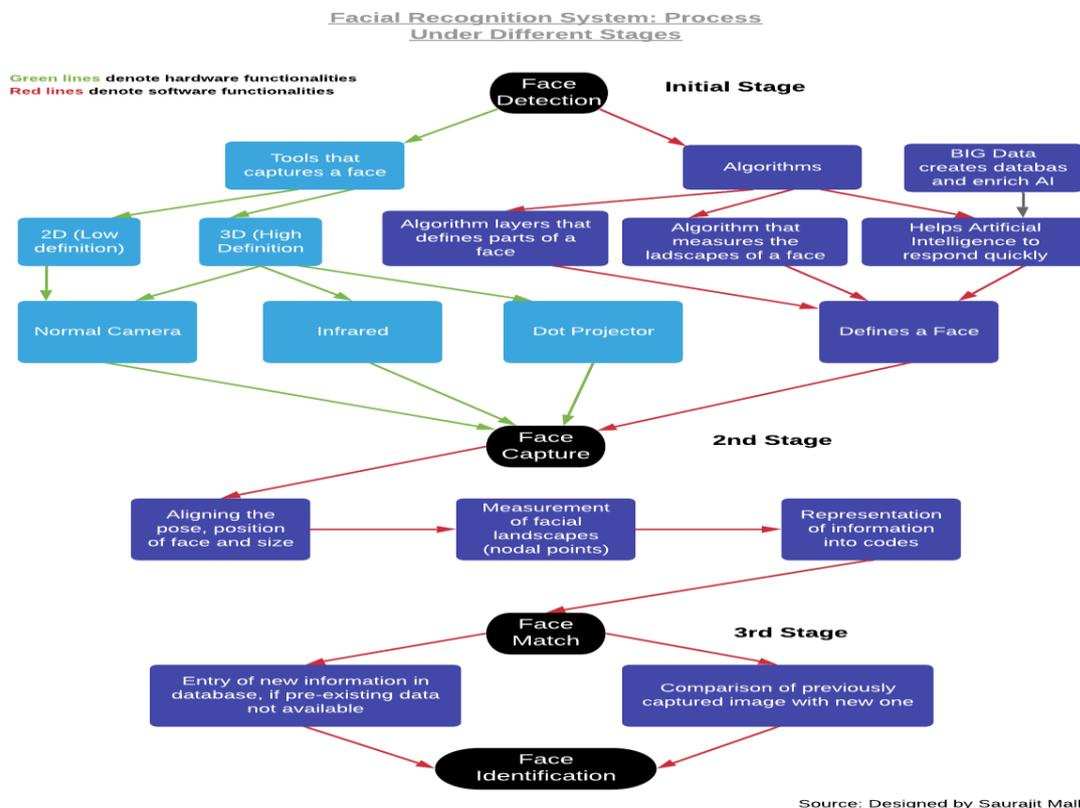


Figure 2: Process flow of the facial recognition system

There are different methods based on which a facial recognition system can work. Theoretically, the principles of facial recognition system follow three principles.

Phase 1: Face Detection:

It is the initial phase of the facial recognition system. A specialised tool, a camera, is used which will capture an

image of the individual. A camera can take a 2D image or a 3D image.

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Taking a 2D picture requires a regular camera. Due to the lack of superior technology and additional features, a face recognition system with a 2D camera can be fooled using a high-quality image (Triggs, 2019). In case of a 3D image, aside from a regular camera, an infrared camera and a dot projector are needed. To be able to capture a face using a 2D camera, the head should be facing toward the camera, making at least a 35-degree angle. However, in the case of a 3D camera, it can take better pictures of a face.

A 3D camera has features that can capture frames from a moving head (Pontin, 2007). When an individual appears in front of a camera, an algorithm activates. It starts searching for a similar face in its database. The database has a vast collection of information and images of individuals. Accessing an enormous database is a time-consuming job. Big Data help enriches the database and creates an environment of Artificial Intelligence that helps algorithms respond faster. Usually, algorithms are laid out in several layers. Each of the layers defines a part of the face, such as the nose, eye, mouth etc. Definition of each part of the face is required to distinguish a face from a hand. There are several landscapes in the faces which are also termed as nodal points. A few of the examples of the nodal points may be distance or space between the eyes, width and length of the nose, depth of eye socket etc. (Thorat et al, 2010). Once the algorithms recognise the object as a face, then begins the next phase of the facial recognition system, which is face capture.

Phase 2: Face Capture:

In this stage, the analogue image captured by the camera gets transformed into a binary code. This is a conversion process that transforms an analogous image into machine language. Meanwhile, while the camera detects a face, the software keeps on sending feedback about the face alignment. The head should be turned toward the camera at least at an angle of 35 degrees (Thorat et al., 2010). However, a 90-degree angle with the camera provides the most effective result. Once the face makes the required angle with the camera, the software starts aligning the pose of the face, the position of the face, size of the features of the faces such as nose, eyes etc. These are all defined as the nodal point and they are measured in microwave (sub-millimetre) length. Now all these information are stored in the database as the form of codes (Thorat et al., 2010).

Phase 3: Face Match

Once the algorithms identify a face and convert all the required information into the codes, it creates a database entry of the information. If the prior information was not on the database then it will create a fresh entry. If pre-existing information is available, then the software will provide relevant feedback or grant access to a pre-defined condition. All of the phases are described in Figure 2 schematically.

Now, if we consider the functionalities on a broad perspective, the functions of the facial recognition system can be divided into two categories. One on the server-side, and another on the client-side. The server-side, for example, acts when an image was uploaded to a server. Facebook could be one of the greatest examples of server-side functionalities of the facial recognition system. When an image was uploaded to Facebook, it uploaded to a Facebook server and based on its database, Facebook recognises the

face in the image and retain information in its database. On the other hand, if it is an office which uses the face detection system to open gates or provide access to secure/classified zones, the functionalities are on the client-side only. Most of the business use both the model, which is a hybrid model. The server side is used for the training, uploading, and maintaining data, whereas the client-side is used for the faster access and retrieval of the data (Thakur, 2019).

Need of Facial Recognition System:

Post the twin-tower incident the need for the facial recognition system had multiplied. Vulnerabilities of the security system in many important places becomes questionable (Introna, Wood. 2004). With the rise of terrorism in public places and schools, authorities are trying to implement a facial recognition system to implement a surveillance system.

Besides, an identification system is paramount in society. To prevent identity theft and security breach facial recognition can be very effective and a quick solution. Since the facial recognition system works on the non-contact method, in public places no other means of the biometric system can be as effective as this one.

Many experts believe that facial recognition system will prevail a longer time. It will become a daily ritual as with all other means of biometric and AI-based technologies. At the same time, they have also mentioned the negative effect of the system. Historical data suggest, that any surveillance system did not prevail for a longer time (Dans, 2019). However, in London, we see an exception. The police are effectively using the facial recognition system to narrowing down the criminal. They have a 98% success rate on detecting criminals using the facial recognition system (Gebhart, 2019).

Use cases of facial recognition system

Banking sector:

In India, there was a strict guideline by the Reserve Bank of India to perform KYC (Know Your Customer). It is detailed information about the customer to better identify future behaviours and prevention from probable defaulting. A recent Aadhar (UIDAI) based eKYC had helped the bank to easily identify and create a database of its customers. Aadhar had already had iris and fingerprint information of an individual. If facial recognition is added then the effectiveness would increase. Though the Aadhar based authentication system had received a non-mandatory status from the Supreme Court, the RBI had allowed the banks to use a facial recognition system for KYC (PTI, 2019).

Since banking and financial institutions are the major users of the facial recognition system, it is highly likely that future banking system would be using numerous methods of authentication, and facial recognition system would be one of the highly used one due to its non-intrusive method of functionalities. As per the report of Biometrics for Banking: Market & Technology Analysis, Adoption Strategies and Forecasts 2018-2023 – Second Edition, by the end of 2020 1.9 billion customers will be using biometrics for banking and financial services (Safi, 2019).

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Security for Mobile devices:

Most of the new generations electronic devices are now equipped with facial recognition system as an added security measures. Android mobiles equipped with its Ice Cream Sandwich version of the operating system was equipped with facial recognition capabilities. However, Apple's iPhone X has perfected the facial recognition system in mobile by using infrared and dot projector-camera (Triggs, 2019). Also, popular computer manufacturers such as Dell, Acer, Microsoft, HP, and Lenovo are manufacturing their laptops with facial recognition capabilities (Paul, 2015). To better cater to the needs of the facial recognition for computer devices, Microsoft had created 'Windows Hello' application for its Windows 10 operating system (Microsoft, 2019).

2020 Olympic Games in Tokyo:

Usage of the facial recognition system in 2020 is a topic of great discussion. The venues of the Tokyo Olympic does not have enough space for the athletes, officials, and volunteers to wait for the biometric security check. The reason why the Tokyo Olympic authority is planning to implement the facial recognition system in the 2020 Olympic game. Facial recognition system has a success rate of more than 99% (BBC, 2018). This will be the first Olympics to have a facial recognition facility.

Hospitality sector:

Hospitality sector can provide a customised service for the guests using the facial recognition system. Hotel Marriott in China had established a guest check-in system at their hotels. Hotel Marriott International had started the initiative in 2018 with a joint venture of the Alibaba Group (Marriott, 2018). During the check-in process, a Chinese guest needs to scan his ID, provide contact details, and take a photo at an automated machine. The machine will verify the identity of the guest and confirm booking details and then provide a key for his room (Jim, Jourdan. 2018).

Marketing and Retail:

Marketing and retail sector can provide great customer experiences to their customers. While a customer enters the retail outlet, a facial recognition system can identify the person. From the customer's previous shopping data, shopping behaviours can provide excellent offers. The same is already true for online shopping. Facebook is already providing customer's behaviour with various retail outlets. As a customer enters the premise, sales representatives get the information on shopping behaviour by Facebook and can direct the customer to a greater experience. American departmental store Saks Fifth Avenue is using a facial recognition system to identify potential shoplifters using a cross-referencing database (Dorfer, 2017).

KFC had come up with a better customer service experience in Beijing, China with the help of Baidu. As the customer enters the outlet, a facial recognition system identifies the customer. Baidu, which is also referred to as Google in China, provides the database of the customers. Based on the age and mood of the customers, it can suggest an appropriate menu to the customers. If the customer does not agree with the menu suggestion, it also provides an alternative item for the customers. Customers can pay the bills using their mobile phone at the facial recognition counter and collect their orders at the counters.

Law enforcement and security:

Amazon is already working on cloud-based facial recognition system called Rekognition to help law enforcement agencies identify criminals. It has the capability of identifying a maximum of 100 peoples in a single image. Drones are using high definition camera for the surveillance purpose. It can detect a person's face clearly who is around 800 meters away from the camera, while it is hovering 100 meters above the ground.

Airport check-in and security:

Sydney airport had implemented a facial recognition-based check-in programme in association with Qantas. This facility will get to the passengers to board on their corresponding flights much faster than the conventional ways of the check-in procedure. In future, it will also cut down the usage of manual verification of passport by using the facial recognition system. It will provide a faster, smooth and convenient process for both the passengers and the airport authority (Ryan. 2018).

In 2017, JetBlue airlines in America tied up with CBP and SITA (biometric technology provider) to provide a self-board facility at the Logan International Airport, Boston for the passengers travelling to Aruba. Later the programme was extended for the passenger travelling to Santiago in the Dominican Republic (Mearian. 2018).

Consumer's perception toward the facial recognition system

As the Alibaba's 'Smile to Pay' service launched in 2017 and successfully tested by KFC outlet at Hangzhou in China, it is evident that the facial recognition system and its usage has quite successful amid its controversies. Consumer perception toward the facial recognition system was sometimes highly appreciated for its convenience, and there were few of the instances where the usage of facial recognition was highly debated. However, undoubtedly usage and adaptation rate of the facial recognition system has risen since its conception (Ogbanufe and Kim. 2015).

A survey conducted by the Center for Identity, the University of Texas in Austin on over 1000 American participants revealed quite a few interesting facts about the adaptation of biometric authentication (German and Barber. 2018). The survey was concerned with all types of biometric in place, which include fingerprint, facial recognition, iris and other modes. It was found that a large number of participants, about one third, were not comfortable with the facial recognition process of biometric authentication. Whereas 58% of the participants were satisfied using fingerprint as the biometric authentication system. At the same time, 92% of the respondents are more confident using the biometric systems than they felt two years ago. The research also revealed that people were more comfortable when the recognition system was used by a private organisation rather than the Government (German and Barber. 2018). The issue might arise from the surveillance news and Government intervention required here to make citizens aware of the usage and policies in surveillance.

A 2018 survey of the Center for Data Innovation suggested that only around 26 per cent of the respondents (American citizens) wants the Government to limit the usage of facial recognition technology.

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When respondents were informed about the usefulness of the facial recognition system for public safety, fewer citizens want the limitation on the facial recognition system. Similarly, the survey also revealed that only 20 per cent of the respondents want a facial recognition system to be limited in the airport area. In the same survey 54 per cent, respondents opposed limiting the facial recognition system in the airport. 49 per cent of the respondents welcomed the decision of using a facial recognition system by retailers to identify shoplifters (Castro, McLaughlin, 2019).

The director of the Centre for Data Innovation, Mr Daniel Castro, mentioned that compared to other forms of authentication system, the facial recognition system was adopted by the people (Americans) quite quickly, and people are widely accepting the regulations since it can provide better public safety and security (Montgomery, 2019).

The above data represents that people from around the world slowly started accepting the facial recognition system in their day to day life. However, the privacy concern remains. Consumers are still worried about how the captured data is being used by various agencies including private and government. It may be mitigated if data collectors provide a mitigated using a transparent and public policy adopted by the agencies. In India, the National Crime Records Bureau (NCRB) had proposed the usage of an Automated Facial Recognition System (AFRS) to the government. Which again, bring the privacy concern of the citizens at front. However, in a more recent turn of events, Delhi and Hyderabad airport introduced facial recognition system enabled passenger entry.

Probably the biggest event that completely changed the consumer perception about the facial recognition system, was the destruction of twin on September 11, 2001. In the pre-9/11 era, the majority of the people believed that the facial recognition system is only suited for Hollywood movie. And even if it is implemented in real life, it would create a hindrance in the privacy issue of people's privacy.

However, post 9/11 the scenario and perception about the facial recognition system has changed significantly. Many believed that there was no dilemma against facial recognition system incorporation at the airport, the 9/11 incident could have been avoided. Post 9/11 era brought some fundamental changes in the consumer's perception about the facial recognition system. People realised it was no longer a sci-fi movie fact anymore. Rather, it could be useful in various realistic scenarios, especially, curbing the security threats at the vulnerable places like airports, railway and bus junctions, important market or business junctions, and even in the sports, where large people gathered together. People had also understood the convenience factors that the facial recognition system can offer them. Many cases we are now realizing the convenience the facial recognition system can offer. Though the privacy concern of the facial recognition system still prevails, the number of people sees it as a threat to the privacy had come down to a remarkably less number.

Figure 3, the shift in consumer perception in the pre and post 9/11 was described. Please note that the numbers put in Figure 3 are only for the representation purpose and not actual value. Those numbers were used where the describe

consumers perception focal point before the 9/11 incident, and how did it get distributed on various other focal points in post 9/11 incident.

The Shift in Consumer Perception of Facial Recognition System: Pre & Post 9/11

*Hypothetical explanation in the perceived consumer perception of facial recognition system

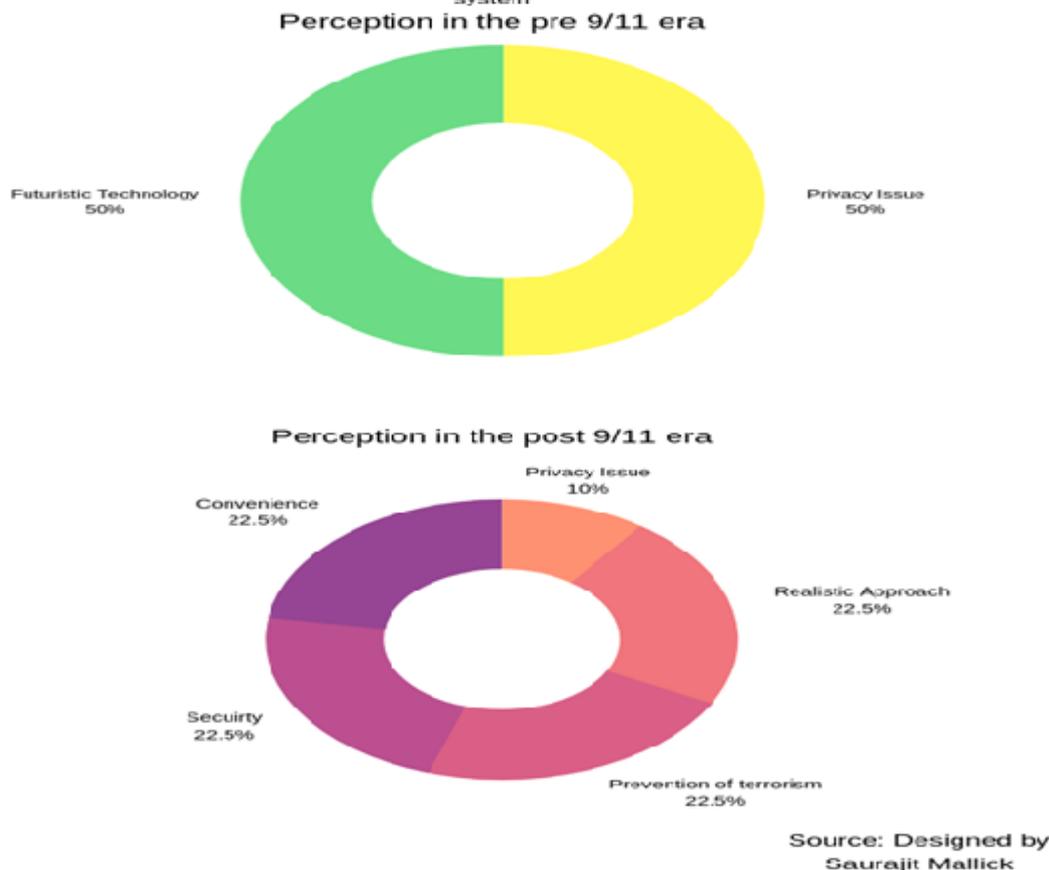


Figure 3: The shift in consumer perception in the Pre and Post 9/11 era

Future growth aspects: It is an inevitable fact that in future there would be numerous instances, projects, and facilities which will be using the facial recognition system for a better and placid operations. The used cases that have been discussed in the ‘Use cases of Facial Recognition System’ will be implemented in a larger scale due to their nature of ease of accessibility in day-to-day lives. Many Governments and commercial organisations has made significant improvements to the advancement of facial recognition system. Many are thinking of contributing a significant amount for further development. In India, the NITI Aayog and the Ministry of Electronics and IT (MeitY) have proposed a contribution of ₹7,000 Crore for the development of Artificial Intelligence¹. Since, the facial recognition system is a functional part of Artificial Intelligence, the investment should also encompass the development of the facial recognition system. On a similar note, the Chinese mobile phone manufacturer, OnePlus, had recently announced its plan to invest ₹1,000 to its newly

built research and development facility at Hyderabad, India. The investment is focused on the development of artificial intelligence². India housed the world’s second largest internet user base, however, the penetration rate (40.90%) is low compared to the top countries with highest number of internet user base. Which, at first sight may appear a negative aspect, however, provides a tremendous opportunity for the technology companies to implement a large scale of operation, which include scope for the facial recognition system³.

Problem Identification:

Often it has been found that a few generations are discriminated against the usage of technology. A few instances suggested that Millennial are the most comfortable people with the adaptation of technology (Murray, 2011). In our research, we are trying to identify whether it is the millennial are most technology adapting generation. Access to this technology in concern, i.e. the facial recognition system, is publicly available through various devices such as

¹<https://economictimes.indiatimes.com/news/politics-and-nation/niti-aayog-meity-spar-over-rs-7000-crore-ai-mission/articleshow/70851052.cms>

²<https://www.businesstoday.in/technology/news/oneplus-to-invest-rs-1000-crore-in-hyderabad-rd-centre/story/375528.html>

³<https://www.internetworldstats.com/stats3.htm#asia>

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smartphones, laptops etc. Even it is available for various Government and private organisation's usage. Unlike other technological advancements such as robotics, which are not accessible by the common individuals, it would be fair to assume that the majority of our respondents are aware of the basics of the facial recognition facilities through their usage of smartphones, laptops, tablets and other devices equipped with facial recognition capabilities. Now, for the bifurcation of Generations, different schools define different age group for a specific generation. For our research purposes, we have considered the following age group bifurcation of a specific generation:

Table 1: Age bifurcation of different generation

Born on	Name of the Generation	Age groups, they belong to, as of 2019
1965 to 1976	Generation X	54 to 43
1977 to 1995	Millennial or Generation Y	42 to 24
1996 onwards	Generation Z, iGen, or Centennials	23 or less

Hypothesis:

- Age groups (Millennial and non-millennial) & adaptation of facial recognition system

In this research paper, we analysed the adaptation of the facial recognition system. There was a perceived consumer perception* that millennial is the only age group which shown higher adaptation rate of technology compared to any other generations (Murray, 2011). To determine the significance of the statement we have considered a null hypothesis which is further sub-divided into three null-hypotheses. Based on the awareness parameter as an independent variable, the first part of the null hypothesis is: $H_{0.1}$: There is a statistically significant interrelationship between higher awareness of facial recognition system and higher adaptation rate of facial recognition system among millennial age groups

Based on the familiarity of mobile application, such as Google Photos, which runs on the facial recognition system, the second part of the null hypothesis is:

$H_{0.2}$: There is a statistically significant interrelationship between familiarity of applications based on facial recognition system and higher adaption rate of facial recognition system among millennial age group. Based on the real-life usage of devices with the facial recognition system, the third part of the null hypothesis is:

$H_{0.3}$: There is no significant relation between real-life usage of devices with facial recognition system and higher adaptation rate of facial recognition system amongst millennial age group

- Facial recognition system and convenience in security and improvement in daily lives & business process

The facial recognition system is not only used for unlocking mobiles and portable devices. It has a significant role in improving convenience in security. Based on this parameter we have suggested the first part of the null hypothesis:

$H_{0.1}$: Facial recognition system have a significant relationship in improving convenience in the security system. Now considering the parameters of the facial recognition system in improving the business process and daily lives, we suggested a second part of the null hypothesis:

$H_{0.2}$: Facial recognition system have a significant relationship improving the convenience of business process and daily lives

Research Methodology:

To test the hypotheses proposed in this research, we have developed a survey questionnaire to identify adaptation and usage rate of the facial recognition system. The questionnaire was distributed amongst a group of individuals which is a blend of different age group people, i.e. baby boomers, gen X, millennial, and centennial. Annexure A represents the questionnaire that has been used for the survey. The questionnaire was designed in such a way that it will navigate the respondent to the next relevant section based on their answer to the previous questions. Thus eliminating the chances of an irrelevant query to an individual where it is not applicable.

Limitations:

In the primary data collection methodology, i.e. survey method of the research, the largest number of respondents were from the millennial age group. Though responses from Generation X and Centennial were received, they were in a very limited number.

Data Analysis:

The survey was sent to 157 individuals belonging to different age groups, out of which 103 responses were collected. Data gathered are briefly described here:

I. Male vs Female respondents:

Around 60 per cent of males and around 40 per cent of female participants responded to this survey.

II. Age groups:

Out of total responded around 1 per cent belong to the baby boomer age group. 1 per cent belong to the Gen X age group. 96 per cent belong to the millennial age group, and 1 per cent belong to the Gen Z age group.

III. Spending on AI enabled & high tech devices:

Out of all the respondents, only around 7 per cent said that they did not spend at all on AI or high technology-enabled devices. Around 31 per cent responded that they spent less than 10,000 INR annually for purchasing high-tech devices. Around 38 per cent spend 10,000 to 20,000 INR annually for high tech devices. Around 18 per cent of the respondents spent 20,000 to 30,000 INR annually, and around 7 per cent spent more than 30,000 INR annually for purchasing high tech devices.

IV. Tech-savvy ness:

Around 45 per cent of the respondents described themselves as the average on a scale of 1 to 5 on the parameter of tech-savvy ness. Whereas 6 per cent of the respondent considered themselves as high tech-savvy.

V. Awareness toward facial recognition system and its usage:

93 per cent of the respondents were aware of the facial recognition system and its usage in mobile devices, surveillance and various authentication system. Only 7 per cent of respondents were not aware of it at all.

To further understand the knowledge of the facial recognition system among the respondents, we have asked the respondents whether they are familiar with the 'grouping of photo' facility in Google Photos. Google Photo uses face recognition technology for the grouping of similar faces into different folders. Around 78 per cent of the users is aware of the facility, whereas 22 per cent are not.

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VI. Information sources about facial recognition system:

A significant number of respondents, nearly 36 per cent, made themselves aware of the facial recognition system through their interest in keeping themselves updated with the recent technology. Nearly 10 per cent get the information from one of the family members, 11 per cent from their colleagues and friends, 18 per cent from newspapers or commercials, and 22 per cent from various websites, blog and videos. Only a 4 per cent of respondents have heard the term but did not know how it works.

VII. Reaction to an environment with facial recognition system:

To understand the reaction of the respondents, we asked them how they would feel being in a place which uses facial recognition system for authenticating them. A remarkable number of respondents, 66 per cent, said they would feel safe, and understand the usage of a facial recognition system to heighten the security of the place. 15 per cent of respondents mentioned that the presence of a facial recognition system would not have any impact on their behaviour. 13 per cent mentioned that they would fully co-

operate with the process, even if they were not aware of the facial recognition system. Rest of the respondents would either leave the place for being in a complicated place like this one or feel very angry for using such a system without user consent.

VIII. Owning devices with facial recognition system:

63 per cent of the respondents possesses a device with the facial recognition system, whereas 37 does not own one.

IX. Performance of the device quipped with facial recognition system:

Respondents, who possess a device with facial recognition capability, were asked to rate the performance of their devices on various parameters. The first parameter that we asked respondents to provide feedback on their devices was Low light performance. Similarly, we also asked to rate the performance of their devices on a few other parameters. Responses were shown in the pie chart below:

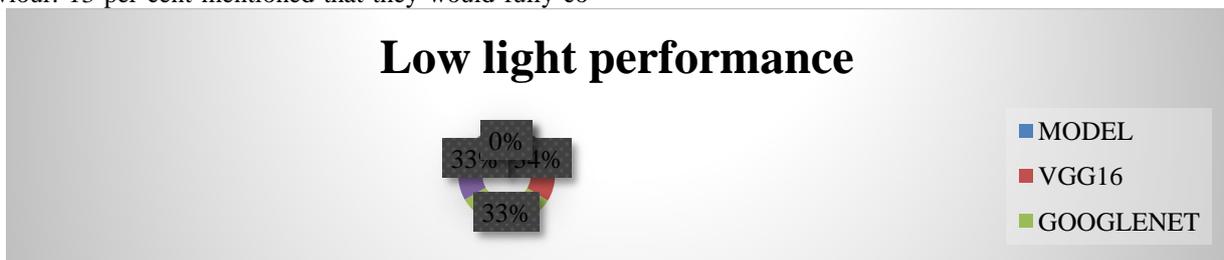


Figure 4: Low light performance of the respondent's personal devices with facial recognition system Response time of the device:

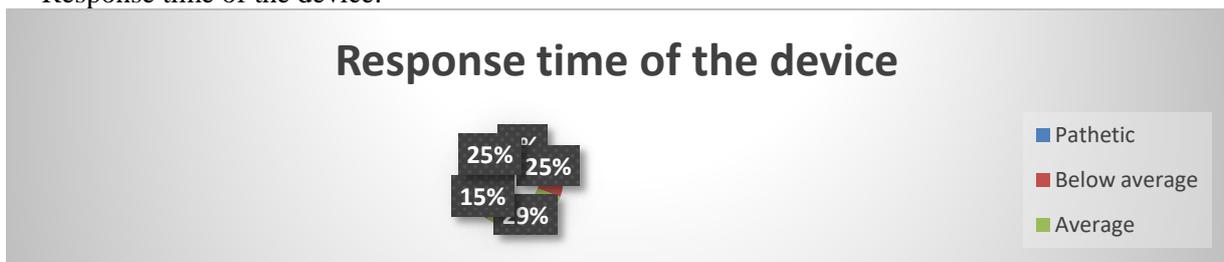


Figure 5: Respondents rated their devices on the parameters of response time

Accuracy:

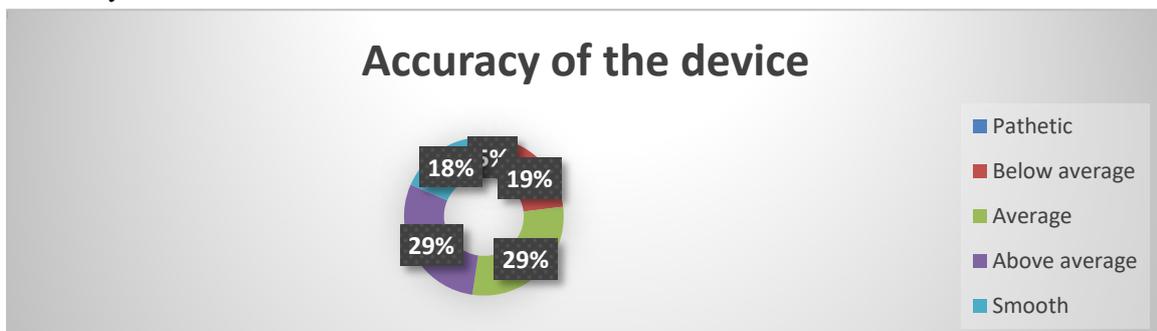


Figure 6: Respondents response over the accuracy of their devices Facial expression:

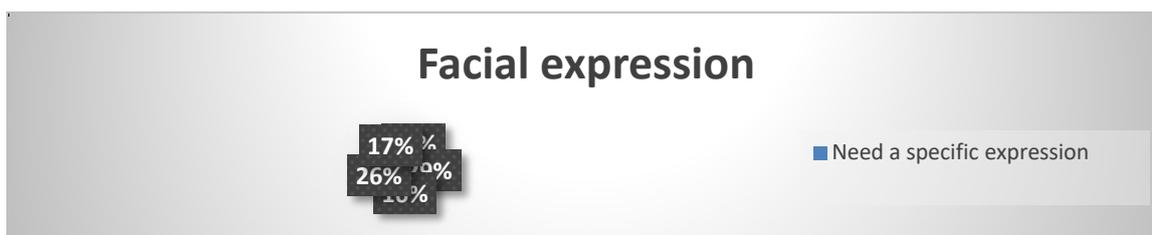


Figure 7: Performance of the device over several facial expression

X. Safety perception of the facial recognition system:

Respondents using devices with a facial recognition system were asked whether they think the facial recognition system provides better security, safety feature, and convenience than other security features. 68 per cent of the respondents replied positively, however, 23 per cent held a negative view. 9 per cent were not at all aware of the added security measures for mobile devices.

XI. Understanding the effectiveness of the security measure of the devices

Sometimes we got the news through various online medium, that a facial recognition system can be fooled using a high-quality photograph of the owner. To understand the reality of this statement, we asked the respondents who had facial recognition system on their devices, whether they ever tried to unlock their devices using the facial recognition system. 78 per cent of the respondents said they never tried to unlock their devices using colour photographs of themselves. However, 22 per cent said they have tried this trick. Out of the 22 per cent of the respondents who tried to unlock their devices using a colour photograph, 57 per cent were successful in unlocking the devices, 43 per cent were not successful in unlocking the devices.

XII. Two factor authentication:

As an added security measure, it is recommended to use the second mode of authentication system such using a PIN code, or a password, or a pattern lock with the facial recognition system, in case if it is the primary mode of the authentication system in the device. We wanted to identify, apart from their primary authentication system, i.e. facial recognition system, which mode of authentication they use the most. 63 per cent use a PIN code along with the facial recognition system. 48 per cent of the respondents use a password, and 57 per cent use a pattern lock as methods of two-factor authentication.

XIII. Future purchase decision:

The respondents who did not possess a device with facial recognition capability were asked if they would like to purchase one in future. 79 per cent of the respondents said they would like to purchase one in future. In the survey, multiple options were provided to understand the factors that influenced the decision. Respondents had the option to choose more than one factors. The options were a family member/peer pressure, ease of use of the device, improved device security, keeping up with the tech trend, and high affordability of these devices. The most influential factor was 'improved device security'. Followed by 'affordability', 'keeping up with the tech trend', 'ease of use', and 'family/peer pressure'.

In the survey, we have also tried to understand the reasoning of the respondents who said they will not be purchasing a

device with a facial recognition system. 21 per cent of respondents responded negatively for this point. Amongst the factors, 'security concern' was the most influential factors. Other factors are 'high cost of such devices', 'complications of setting up the facial recognition facility', and 'fear of abuse' by others.

XIV. Usage of facial recognition system in other areas:

The survey asked the respondents to provide their opinion where they feel that the implementation of facial recognition system can be very beneficial. Most of the respondents thought the lock system for premium housing and authentication in the banking system would be the areas which can be benefitted most by the usage of the facial recognition system. Next, respondents shared their views that airport check-in system and attendance capturing system could be greatly benefitted by the facial recognition system. E-commerce, mobile banking applications, features in smart cars, non-financial authentication systems such as the delivery of goods can avail the benefits of the facial recognition system.

Hypothesis Testing and Findings:

• Age groups (Millennial and non-millennial) & the adaptation of facial recognition system

To test the first part of the null hypothesis, we have performed the test of significance based on the survey data we have gathered. The first part of the null hypothesis is:

H_{0.1}: There is statistically significant relationship between higher awareness of facial recognition system, and higher adaptation rate of facial recognition system among millennial age groups

The data is represented in the Table 2:

Table 2: Data representation for Hypothesis testing H01

		Age Group			
		Centennial	Millennial	Gen X	
Awareness of Facial recognition system	Yes	Actual	1	93	2
		Estimated	0.932	92.2718	2.796
		Chi Square	0.0049	0.0057	0.2266
	No	Actual	0	6	1
		Estimated	0.0679	6.7281	0.2038

A Chi Square test result is described in Table 3:

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Table 3: Results of Hypothesis testing for Hypothesis H01

Chi Square	3.49278
Degree of Freedom	2
p Value	0.1744

Since the p-value is greater than 0.05, we fail to reject the first part of the null hypothesis. It can be said, that there is a statistically significant relationship between awareness of the facial recognition system and higher adaptation rate of facial recognition system in a specific age group, i.e. millennial. The significance test proves that the adaptation rate is high amongst the millennial age group compared to all the other age groups in the sample population. From a business perspective, the result holds a significant value. May be business and technologies should consider age specific awareness programmes for better adaptability of the facial recognition system amongst other generations. In a few years, the Centennial generation will be joining the job group or they already have started joining the workforce. Similarly, a focused strategy for creating awareness amongst the Gen X age group will help them better adapt to this technical environment. Lack of awareness may generate fear of abuses and may overlook the benefits that can be achieved by using a facial recognition system. For the second part of the null hypothesis, we have considered an independent variable, familiarity with the applications of the facial recognition system.

H0:2: There is statistically significant relationship between familiarity of applications based on facial recognition system and higher adaption rate of facial recognition system among millennial age group

The data for testing is represented in Table 4:

Table 4: Data representation for Hypothesis testing H02

		Age Group				
		Centennial	Millennial	Gen X		
Familiarity of applications which works on facial recognition system	Yes	Actual	0	78	2	
		Estimated	0.7766	76.8932	2.3301	
		Chi Square	0.7766	0.0159	0.0467	
	No	Actual	1	21	1	
		Estimated	0.2233	22.1068	0.6699	
		Chi Square	2.7015	0.0554	0.1626	
Chi Square		5.817				
Degree of Freedom		2				
p Value		0.05455				

The result of the Hypothesis test is mentioned in Table 5:

Table 5: Test result for Hypothesis testing of H02

Chi Square	5.817
Degree of Freedom	2
p Value	0.05455

Since the p-value is greater than 0.05, we fail to reject the second part of the null hypothesis. It can be said that the millennial age group are more familiar with the facial recognition system and they show higher adaptability rate of the system compared to all the other age groups in the sample population. From a business point of view if we consider the test result then there is a scope for the business to improve higher adaptability rate of the facial recognition system, assuming that the simpler applications can be used to increase the familiarity as well as adaptability rate. Fear of failing to set up the device, or fear of not being able to cooperate properly in an environment with a facial recognition system, may have contributed for the lesser adaptation rate amongst other age groups. Simpler applications, with easy to understand instructions may be more appropriate for the other age groups. For the testing of the third part of the null hypothesis, we have considered real-life usage of a device, capable of face recognition, to test with the age group factors. The third part of the null hypothesis is:

H0:3: There is no significant relation between real-life usage of devices with facial recognition system and higher adaptation rate of facial recognition system amongst millennial age group

The data for Hypothesis testing is represented in Table 6:

Table 6: Data representation for Hypothesis testing H03

		Age Group				
		Centennial	Millennial	Gen X		
Real-life usage of devices with face recognition capabilities	Yes	Actual	1	64	0	
		Estimated	0.631	62.4757	1.8932	
		Chi Square	0.2156	0.0371	1.8932	
	No	Actual	0	35	3	
		Estimated	0.3689	36.5243	1.1068	
		Chi Square	0.3689	0.0636	3.2383	

The result of the hypothesis testing is mentioned in Table 7:

Table 7: Test result for hypothesis H03

Chi Square	3.759
Degree of Freedom	2
p Value	0.1527

In this test result, the p value is very close to 0.05. A marginal value of p can work of favour of the hypothesis or against it. A specific result cannot be attained here in this test and hence we cannot reject or accept the third part of the null hypothesis.

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- **Facial recognition system and convenience in security and improvement in daily lives & business process**

In the survey, respondents were asked to provide their opinion about the areas where facial recognition can provide improvement and convenience in security and business. Respondents were given multiple options to choose from and can provide their opinion in more than one parameters. Based on their response we have grouped the parameter as convince in security, to test our hypothesis. The first part of the hypothesis is:

H_{0:1}: Facial recognition system have a significant relationship in improving convenience in the security system

Data for hypothesis is represented in Table 8:

Table 8: Data representation for Hypothesis testing H01

	Convenience in Security parameter of Facial recognition system	
	Actual	Estimated
Lock system for premium housing	65	62.3333
Banking system and authentication	65	62.3333
Airport check-in	57	62.3333

The p value of Hypothesis test is = 0.710173358

Since the p-value is greater than 0.05, we fail to reject the first part of the null hypothesis. It can be said that there is a significant relationship between facial recognition system and convenience in a security system. The facial recognition system is capable of bringing several convenience factors in security.

For the second part of the null hypothesis, we have grouped a few other parameters for the hypothesis testing. The second part of the null hypothesis is:

H_{0:2}: Facial recognition system have a significant relationship improving the convenience of business process and daily lives

The data is represented in Table 9:

Table 9: Data representation for Hypothesis testing on H02

	Ease of business and daily lives using facial recognition system	
	Actual	Estimated
Attendance capturing	57	49.75
Smart-car ignition	46	49.75
Delivery of high value items	42	49.75
Payments for e-com apps	54	49.75

The p value for the test is = 0.405782408

Since the p-value is greater than 0.05, we fail to reject the second part of the null hypothesis. There is a significant relationship to between facial recognition system and its application in the business process and daily lives to improve the functionalities.

Limitation of the study:

In the primary data collection method, i.e. survey method, we received the highest number of responses from millennial age groups. Though we received responses from non-millennial age groups, hut in a limited quantity. This study has a limited understanding of consumer perception for the non-millennial age group.

Scope for further research:

An in-depth study is required where review from all the age group can be drawn. Qualitative research can be further taken into consideration on consumer perception about the facial recognition system and improved marketing strategies for the better adaptation rate among the non-millennial age groups.

III. CONCLUSION:

This research study under the caption “understanding facial recognition system usage and adaptation among millennial and non-millennial consumer” is based on the primary data as well as secondary data. It is a micro-study, however, the conclusion drawn may be extended to macro behaviour of the economy. Millennial age group, which covers the highest percentage of Indian population shows a higher affinity toward technology. Naturally, their adoption rate is higher among all other generation. However, to make other generation interested in facial recognition technology, there is a need for dissemination of information. The Indian market is a blue ocean market, i.e. a developing market. Most of the advancement in facial recognition system was from the red ocean market, i.e. developed markets. The red ocean markets will try to penetrate the blue ocean market and the Indian market will be one of the most ideal markets in that scenario. The future perspective appears to be bright if the technological progress is associated with marketing acumen and strategic dissemination of information for all age groups.

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