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TECHNOLOGICAL AND BUSINESS PERSPECTIVE OF WEARABLE TECHNOLOGY

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ABSTRACT

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Recent developments in sensor and communication technologies have provided novel applications for the betterment of people in daily life. Wearable technology is one of among such recent technology trends adopted by users in order to get various services in healthcare, fitness etc. The central idea of this thesis is to provide the overall viewpoint of wearable technology towards our society. The aim of my research work is to explain the recent and popular applications of wearable device and their benefits in our daily lives. Moreover, it shows, that how these wearable devices can be socially adopted in various sectors. This research work also highlights the current major technological issues, which effect the popularity of wearable technology.

This thesis work also presents the popular wearables companies who are providing wearable services in Finland. Furthermore, the specific objective of this thesis was to find the consumer perspective of wearable technology in Finland. To analyse the consumer perspective, a survey was conducted in various parts of Finland, which has given the comprehensive understanding of consumers' viewpoint towards wearable technology.

The outcome of this thesis is reliable for both the consumer and business perspective. The consumer will get an idea about various wearable devices, which helps them to choose those devices that satisfy their demands in a more efficient way. However, this research work is also valuable for the companies to know which wearable devices are popular in Finland and which devices are most useable in different age groups. It also helps companies to generate higher revenues by recognizing currently the most demanding wearable devices.

Key words

Social aspects, Technological and business perspective, Wearable application, Wearable technology

CONCEPT DEFINITIONS

ASSIST	Advanced Self-Powered Systems of Integrated Sensors and Technologies
CAGR	Compound Annual Growth Rate
FIDO	Facilitating Interactions for Dogs with Occupations
HET	Health and Environmental Tracker
IOT	Internet of Things
LBS	Location Based Services
NFC	Near Field Communication
WSN	Wireless Sensor Network

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1 INTRODUCTION

In recent years, development in technology has changed the attitude of living of human beings. People are experiencing those things, which they only dreamed about decades ago and was considered as impossible in real life. Wearable technology is that technology which has changed the lifestyle of human beings. Wearable technology has been around for many years, but the craze of wearable technology begins when the prototype of Google Glass was first developed. The prototype of Google Glass has changed the view point of individuals. It helped users to start thinking beyond reality. Before the prototype, users were unaware about wearable technology. Nowadays there are various exciting products that are available in the markets and in the future it is expected to play an important part in our daily lives.

In the past years, it has been difficult for ordinary people to check their basic physical health attributes by themselves. They had to visit hospitals and clinics to check their blood pressure, sugar, cholesterol and other physical activities. But today with the help of wearable technology, they can check all these basic health related details and monitor fitness activities, everywhere and at any time. Previously physicians were using different apparatus for the check-up of the patient, but nowadays one smart wearable apparatus can be used for multiple purposes.

Further, wearable technology is the integration of technology with regular accessories which make user's life easier. Nowadays, if someone is aware of the latest smartphones, they are also familiar of the new smartwatches which shows that wearable devices are becoming popular day by day. The purpose of the wearable technology is to provide faster access on technology by saving time and effort of the users.

Basically, the phenomenon of wearable technology is not new. During the last decades, various wearable devices have been designed and developed which are used for many purposes. But the trend is getting faster now, as in 2010 many of the wearable devices were developed and most of them are used to monitor fitness activities.

Elderly people are facing high level of disabilities because of the age-related diseases, therefore they need greater care and assistance. Most likely, they are admitted to a nursing home or hospital, but this is not the permanent solution for them. The reason behind is that elder peoples prefer to stay in their own home and provided care from the nursing home is also an expensive way. In that case, wearable technology is playing an important role to solve this particular problem. It continuously monitors the physical

activities of elder people which minimizes the risk of illness and injuries. With the help of wearable devices, they can observe their own health activities and measure, blood pressure, heart rate, calories burned etc. (Chan et al. 2012.)

On the other hand, wearable technology has been used in various field, which includes education, finance, gaming, music and entertainment. But healthcare is the most potential and prominent sector for wearable technology. With the help of wearable technology, the healthcare industry provides beneficial products to healthcare users. It is also the key market for the early success of wearable technology.

Overweight and obesity have become common among adults. In the Unites States 37.5% of the population is obese or overweight. When a person become overweight, he or she has a greater chance of heart diseases, diabetes and strokes. The reason behind the obesity may be the lack of regular physical activities. Therefore, it is important, for individuals to take part in physical activities regularly, so that they can reduce their weight. To overcome this issue, various studies suggest that self-monitoring and receiving feedback is one of the possible solutions to solve this problem. (Nieves 2014, 1.)

For that reason, various technologies have been made for those who are willing to monitor their physical activities. Wearable technology is among the best ways which provides easy and effective ways to overcome individual's weight problems. Smart bands, fitness trackers, smart watches are such kind of wearable devices which can record the physical activities of the users throughout the day and also provide suggestions and feedback to users by monitoring their behaviour. From these devices users can also send their physical data to their instructor, so that they can give feedback to them by analysing the data.

Wearable technology promises to help users to live healthier lives with less cost. Technological companies are also willing to create more and more advanced wearable devices because of high demand of these devices in the market. One of the popular wearable devices is the fitness band that monitors sleeping patterns and physical activities of the user. It also detects heart rate, temperature, hydration level and so on. (PwC 2014.)

These devices producing enormous amount of data, which is not only useful for the consumers to manage their own health but also helpful for the healthcare organizations to provide better health care facilities. It also helps in reducing costs through remote patient monitoring system. Further, personal data of individuals is also used by the employers and insurance companies to manage wellness and healthcare cost. Employers are estimating their health care costs by analysing the employee's personal data, however

these data support insurance companies for reimbursement of claims and reduce the cost of trials. (PwC 2014.)

The most preferable wearable devices are the activity trackers and smart watches. From these devices organizations are collecting a huge range of personal data of users, such as heart rate, location, exercise level, behaviour, and so on. It is a great opportunity for the organizations to analyse these data and use them to build strong relationship between their customers. For example, the taxi firms can send quotes to their customer by monitoring the regular walking routes during bad weather. It is not only beneficial for the organization but it is also helpful for the customer in wet conditions. It is also an effective way to do business by analysing the customers' expectations. However, restaurants offer the specific foods to their customers, which is based on the weight-loss goals and level of activities. Therefore, to develop a successful enterprise, it is essential to analysis the sophisticated data of users. So that organization is aware from the customers' expectations. (Eaton 2016.)

Even though wearable technology has a great amount of potential, but still there are several issues in it. Security, communication capacity, power consumption, privacy are some challenges which is faced by wearable technology. These devices have a small processor therefore it has less security measures compared to other computing devices. Therefore, safety and privacy of the users are at risk, which may reduce the demand of wearable devices in the future. One of the main challenge in the wearables is that these devices are not standalone devices, they have to contact with other gadgets to perform most of the functions, such as smart phones. These types of complications are reason for security issues in wearable devices.

Measure contribution of thesis

Following objective are covered in my thesis work.

- I explained the recent various popular wearable devices which are commonly used nowadays.
- I defined some of useful application in various fields of daily life.
- I analysed the impact of wearables on the social life.
- I highlighted technological issues that currently users and manufactures face.
- I studied available well-known companies of wearable devices
- I analysed the current market trend of wearable devices in the world from different perspectives.
- I conducted a survey in Finland on the consumer's perspective for wearable devices.

The purpose of the survey is to know the current consumers trend towards wearable technology in Finland. In this survey, I analysed which wearable device is most interesting and most popular among consumers and which age groups have adopted most wearable devices in Finland. Further, this study can also be helpful for wearable companies to develop more attractive wearable devices in Finland so that the business can be improved. It is also helpful for the companies to predict future trends of popular wearable devices in Finland which eventually will be the potential driving force to generate outstanding business revenues.

Furthermore, this thesis is also linked with Centria's I3 –project Innovations & Industrial Internet. It belongs to the EU-program Interreg V A Nord, which is a supporting cross-border cooperation to strengthen the economic and social development. The aim of the I3 project is to innovate and support the usage of modern technology in small and medium sized enterprises in the region. The three main topics of the project are digitalization, industrial internet and open innovation, which all are important aspects in wearable technology.

Overall, the thesis is based on the five different chapters. first chapter of thesis is the introduction part that explains the thesis structure and overview of the thesis. 2nd Chapter of the thesis provides the general overview of wearable devices and explains what wearable devices are and the background of wearable technology. It also explains the most popular wearable devices in the market, such as smart glasses, smart watches, smart clothes, smart shoes fitness bands/trackers. However, the 3rd Chapter explains the technological and social aspects of wearable devices, that contains the applications of wearables, technological issues and challenges of wearable devices and social aspects. Subsequently, Chapter 4 describes the business aspects of wearable devices in general. Chapter 5 is a research study which was conducted to know the viewpoint of Finnish people towards wearable technology and Chapter 6 is explaining the outcome of the thesis.

2 OVERVIEW OF WEARABLE DEVICES

2.1 History

Wearable technology is enormously popular these days. It is not precisely new but over the decades the concept has been getting more sophisticated. Reason being that wearable technology has increases human capabilities by wearing wearable computing devices.

In 1961, mathematics professors of MIT Edward Thorp and Claude Shannon invented the first wearable computing device which successfully gave the wearer an upper hand at roulette. Further, the device contributed the wearer a 44% edge in the roulette game. Moreover, 11 year later, Keith Taft developed a wearable computer which was used to get advantage in Blackjack. He titled the device "George" and placed the device in his shoe. He stopped using this device when he lost more than $4000 in one weekend. (Zensorlum 2016.)

Furthermore, in 1970s wearable technology took little popularity in the mainstream market, when further wearable devises were released. "Pulsar Calculator Wristwatch", is the world's first calculator wristwatch, which was released in 1975. It became widespread tool for math nerds and science geeks. These types of smart watches got huge success in the mid-1980s and their popularity went up. Still there are many companies that produce calculator watches even today. (Zensorlum 2016.)

After sometime, Steve Mann, who was an early pioneer in the area of wearable technology, did a lot of advancement in the computational photography and wearable computing. In 1981, Steve Mann, the top researcher had developed a backpack-mounted multimedia computer that controlled camera for photography. After thirteen years of inventing backpack devices, Steve improved the same concept and created the wearable wireless camera in 1994. From the wireless camera, he was uploading images to the web until two years and became a" first life-logger". It was the first example of life-logging. (Paulson 2014.)

However, in 1994 Mike Rucci and Edgar Matias from the University of Toronto, Canada developed the first "wrist computer" that was strapped to the user's forearms. While in the same year, Mike Flynn and Mile Lamming established the Forget-Me-Not device which is used to continuously record and store the communication between people and device in it database. The purpose of recording and storing data in the device for later query. (Baumann 2016.12)

In the 21st century. wearable technology has bought new innovations which has helped wearables to take off in the technological market. In 2002, Nokia presented the Bluetooth headset, with the help of new Bluetooth technology. The headset allowed users to receive calls without using their hands. This headset achieved great popularity in that time and still many users are using it. Further in 2006, Nike and Apple team have created a fitness tracking kit which is used to track the movement of the users. With the help of shoe embedded tracker, users can view the real time, distance covered, pace and calories consumed through workout on the Nano screen of iPod. (Desjardins 2015.)

Furthermore, Fitbit brand is one of the most popular brands in the wearable market. Fitbit considered as one of the pioneer company in market by releasing Fitbit classic in 2008. Moreover, in 2011 wearable technology got a tremendous boost, when Google developed the first prototype of smart glasses which is called as Google Glass today. After two years, in April 2013, Google Glass was publicly released. The features of Google Glass have changed the viewpoint of the users in various aspects. It can be controlled by the touchpad which was built into the side of the glass and also with the voice recognition software. However, it is one of the most popular and innovative wearable devices, but due to the privacy problems and some other issues, it is banned in serval commercial areas. However, several companies have jumped in the smart wearable market, to produce innovative wearable devices when Google Glass was famous in the technological market. (Baumann 2016.)

In late 2014 the first solar jacket was made by the Tommy Hilfiger, which allowed users to charge their phone on the go. Further, 2014 was called as "The Year of Wearable" because wearable technology brought out numerous products in the market (Baumann 2016). In 2014-2015 Wearable technology, has released various forms of wearable devices, which includes smart glasses, watches, E-clothes, head-bands, jewellery, etc. Further, Apple, Samsung Song, Fitbit and others companies invented wearable devices which also achieved huge success in the market.

A young person, Palmer Luckey, invented the Oculus Rift. It was released publicly on 28 March 2016. It is a virtual reality tool in which users can experience the virtual world. (Baumann 2016.) Today the demand of wearable devices has progressed. These technologies and devices have changed the life style of people. In the future, we will see new developments in the wearable technology and also it will come up with the Internet of Things.

2.2 Wearable Devices

In recent years, wearable technology is one of the hottest topic in the technological field. The area of wearables is still in the beginning phase, but it is growing rapidly and capturing the market with great success and marvellous speed. Wearable devices are small computers, which can be integrated into different objects. Individuals can comfortably wear them on their bodies in order to get required services. Also these devices can do multiple tasks which are similar to what could be provided by mobiles and laptops. But in some cases, these devices can give outstanding performance compared to hand-held devices especially in the healthcare. These devices have tendency to provide sensory and scanning features, such as bio-feedback and tracking of biological functions. (Wearable devices 2014.)

Furthermore, wearable allow humans to access information in real-time because these wearables have some form of communication capabilities. Rapidly growing examples of wearable technology includes smart glasses, smart jewellery (rings, and bracelets), contact-lenses, smart watches and e-clothing. Globally, the demand of wearables among youngsters are increased because of easily usable and good for stylish purpose. Wearables collects huge amount of data as it tracks many features of users in daily life.

There are many wearable devices which will tell us about our physical activities, just like smart wrist watches which tell about various health and well-being information. Fitness trackers is one of the useful and appropriate device to measure physical attributes. Fitness tracker is a wireless device which has different sensors attached to it. We can measure our breathing rate, consumed calories, distance travelled, stress level, sleeping pattern and other different types of fitness activities from the fitness trackers. Therefore, these technologies will help users to maintain overall health by providing physical information to their users. For example, in the case of smart glasses we will get unlimited information in front of our eyes and if we want to monitor our health we can use fitness tracker which will provide all the information of our wellness. From wearable devices, health features of various individuals can be analysed, rather than going for check-up physically at each time, these devices can provide continues report to doctors which helps in patient's recovery. (Qualcomm 2016.)

Further, there is also an app called "tracks workouts", which can work with smartphone sensors. This app can track and acts like a personal trainer. It monitors the daily activities of consumers and based on these activities it will suggest the suitable workouts for the consumer and sends inspiring texts. For example, message like if user didn't sleep well last night therefore tracker will suggest that it is essential that user should go to sleep earlier today. (Qualcomm 2016.)

Wearable applications are simple and effective. Wearables are dominating smart phones in many cases. Consumers can use Facebook, twitter, WhatsApp, Instagram, emails and other useful applications from wearables. Wearable technology is trying to get users to engage in the real world. In the case of smart phones, it's the opposite because smart phones are actually damaging our social life because everyone is engaged in using smartphone and giving less importance to the social activities.

Location based services (LBS) are one of the applications available in wearable devices which are providing services and information to their users. LBS has different viewpoints and it has application in various domains such as entertainment, health and personal life among other activities. An important feature of the wearable is that it also provides location based services to their users. Location based services collects the real-time data from their users. Based on that data, it monitors the current location of their users and based on that suggest the user relevant services. In the whole world, many peoples are not able to get direct help with health professionals. But users can get immediate help from the location based services. Further consumers can produce a lot of data to analyse their own physical fitness by using location based services. They can check their running capabilities, pulse rate and other fitness activities. Also from these devices they can see the complete route map, which helps them to find the right locations. (Adelabs 2015.)

Moreover, experts strongly believe that in the future, wearable technology along with Internet of Things (IoT) will play an important role in our everyday lives and provide more concrete applications. They also say that wearable technology will have brighter future from both social and economic perspective. The concept of IoT tells that everything such as, all the objects, devices and systems, will be connected to the Internet and users can share all the information everywhere at any time. In the future, vision of IoT can be used in medical and wellness wearables such as smart watches and fitness trackers. These wearable devices will track and measure pulse rate, heartbeats, saturation of oxygen, sleeping behaviour and other physical activities in real time. In the case of emergency, these IoT devices can communicate and send all the real-time data of the patient to professional's doctors or trainers. IoT can provide current condition of the users, so that professionals and trainers can take necessary steps to save users' lives. (Murphy 2014.)

Wearable technology is playing an important role from the business perspective. It is beneficial for businesses in various ways. In emergency situations, workers can save valuable time by using smart-watches, rather than using mobile phones. Further, tracking devices are also helpful in the military. Because from the tracking devices, army generals can monitor the exact location of their soldiers.

2.3 Popular Wearable Devices

Wearable technology is tremendously popular in various fields these days. It is continuously growing and filling the gap between the technology and what we wear. The concept of wearable technology is not new, but it has become for sophisticated over the decades. There are several wearable computing devices available in the market but the most popular wearable devices which have got huge popularity in the consumer electronic market as explained below.

2.3.1 Smart Watches

A smartwatch is a wearable device which is similar to a wristwatch or a time-keeping device. It does not only show us the time but also has the ability to do a great number of smart tasks very efficiently which previously could be done through smartphones. Thus, it is also known as a wearable computer. Users can wear smartwatches and can perform many operations such as to answer the phone calls, reading and dictating text messages and emails, analysing the physical activities, monitoring fitness and health related activities and listening music among others. These types of devices have wireless a Bluetooth adapter which is connected with smartphone or through Internet of Things (IoT). (Rouse et al. 2014.)

It is important for an active sports person to maintain and mentor his fitness regularly and thus they require one of the best smartwatches. From the smartwatch, sports personnel can record fitness activities on a daily basis. They can constantly check pulse rate, heart-beat, calories consumed and so on. If they feel some changes in their body, then they may look for medical help if necessary or alter the diet. (Morrell 2016.) Furthermore, these wearables are very useful for runners because it calculates every step and it has inbuilt GPS as well which precisely tacks the runs. Moreover, it also has storage capability, which helps users to store large amounts of data in it, from Picture 1 it can see that how smartwatches have full mobile phone capacity. Therefore, the smartwatch is playing a crucial role for the sports personnel who wants to achieve success in their life by holding a good place in sports.

PICTURE 1. Smart Watch Wearable (Wearable Technology, slide 11)

Further, users can connect any smartwatch with their smartphone, even though the users are miles away. It can happen when both the smartwatch and smartphone are connected to the Internet. At that point when these both are connected then users can access their emails and necessary messages through their smartwatch. Another important feature associated with smartwatches is that consumers can use and access the voice services. It will reduce their effort of typing long text messages when time is short. Voice applications are very vital in smartwatches in the case of emergency situations to contact with particular authorities, without wasting a second. Furthermore, it can also inform about situations which are related to our daily activities such as weather, social updates, breaking news and other regular information by sending alert notifications to our mobile devices. These alerts help users to connect with the world and inform us what is going in around. (Fuchs.)

Battery life is one of the biggest challenge for the smartwatches. Wearers expect that batteries of smartwatches will last for many years and thus they are not willing to charge the battery on regular basis which may lead to reduction of lifetime of wearable device. (Hamblen 2014.) Therefore, increasing battery life is one of the major concern for the researchers. They are trying to find such solutions which

can take the less energy and power requirements. On the other hand, size and weight are also main issues in smartwatches. Subsequently, users are comparing smartwatches to wristwatches. Therefore, they expect that smartwatches should be comfortable and reliable in wearing. Also users prefer to have stylish and sleek smartwatches. It is also important to have user friendly smartwatches so that any common user can operate it easily.

Smartwatches have various applications in various fields. In the case of emergency, hospitals and ambulances are receiving medical data of patients with the help of smartwatches and then these authorities are immediately taking some prompt steps to save patients life. From the smartwatches, patients can predict the heart attacks and strokes time to time.

Nowadays, the market of smartwatch is in full swing. Sensational and capable devices are available in market for sale. Therefore, it is hard for users to make buying decisions. There are many companies, who are manufacturing smartwatches for the last couple of years. Apple, Google, Samsung, Sony, Huawei, Pebble are those companies who have created impressive goodwill in the wearable market. Currently Samsung Gear S3 and Apple Watch are the famous brands in the market.

Apple Watch

Apple Watch is fulfilling the customers' demands. It is sophisticated and comfortable watch which can fit most people's style. Further, the notification system, fitness trackers, collection of apps are quite solid in it. Therefore, Apple Watch is considered as one of the best looking smartwatch which has all character and most importantly user friendly. (Lamkin 2016.)

Samsung Gear S2

Similarly, Samsung Gear S2 is also a kind of smart watch which as has most GPS features. Also the battery life in Samsung Gear S2 is much better than their competitors (Lamkin 2016). Because of battery timing and GPS features, it has achieved a great success in market.

Huawei Watch

Huawei watch is called one the best wearable android device from style perspective. It may be because users haven't seen such a stylish and nice looking device before. It suits on the both male and female but still, it is mostly preferable by males. Also for the sleek design, everyone prefers to wear it. (Boxall 2016.)

2.3.2 Smart Clothes

Smart clothes are an electronic device that monitors the physical conditions of the wearers. These devices are excellent wearables. It has biosensors, which measures body temperatures, hearts rhythm, pulse rate, muscle starch and other physical movement of the body. (PC 2016.) Picture 2 shows the latest prototypes and innovation of smart textiles. Further, smart clothes have capability to store data, display videos and messages, internet connectivity and so on. Also its changes the colour of the cloth, recharge battery from movement of the users and record user's activities.

PICTURE 2. Smart Textiles with Latest Prototypes and Innovations (Furniere 2016)

One of the benefit of the smart clothes is that it is not conspicuous, as compare to other wearables such as smartwatches and fitness bands. It is like a device where user don't have to take off, no issue of charging and no thinking at all. The user just has to wear it and then it will work and complete all the tasks automatically. Smart clothes look like normal clothes. These clothes are light, soft and flexible and also available in different styles, colours and tremendous varieties. (Gokey 2016.)

Furthermore, smart clothes have embedded sensors that monitors all the activities of the users throughout the day and give suggestions to users according to their mood. Experts think that in the future everyone will wear smart clothes, reason being that these clothes are convenient and useful and ability to connect humans to their daily activities. Motion detecting pants have embedded sensors that measures the rotations, speed and flexibility of pants. Also, it sends these activities to our handheld gadgets with the help of wireless signals. (Macmanus 2010.)

Samsung Smart Suit

Samsung Smart Suit is a business suit for men, which has embedded near field communication (NFC) button on sleeve. NFC tag connects to a mobile device to open apps and exchange contact data. The tag also lets wearers unlock their phone as they take it out of their pocket, or exchange business cards digitally. Users can also set different modes on the phone, like drive mode or office mode. (NXP 2016.)

Samsung Swing Golf Wear

Further, when an NFC device taps the garment's NTAG tag, the tag launches a mobile app that gives golfers information about the course they're playing. For example, golfer can see the distance from the current location to the hole, get extra information about their golf club, or check weather and UV ratings. (NXP 2016.)

Welt Belt

Welt Belt is a wearable device, which is designed to solve health related issues. It is a smart belt that was invented by the Samsung company. The main purpose of this belt is to check the physical health of users. Further, it is a type of wearable which measures every movement of the users, such as sleeping time, eating time, waist size (time to time) and so on. After collecting the all data of the users, it suggests users to do some tasks to improve their physical health. It looks like a normal belt but still it has different internal features. Also, the welt belt has amazed fashion industry, for its fashionable design. (Clark 2016.)

Life Belt

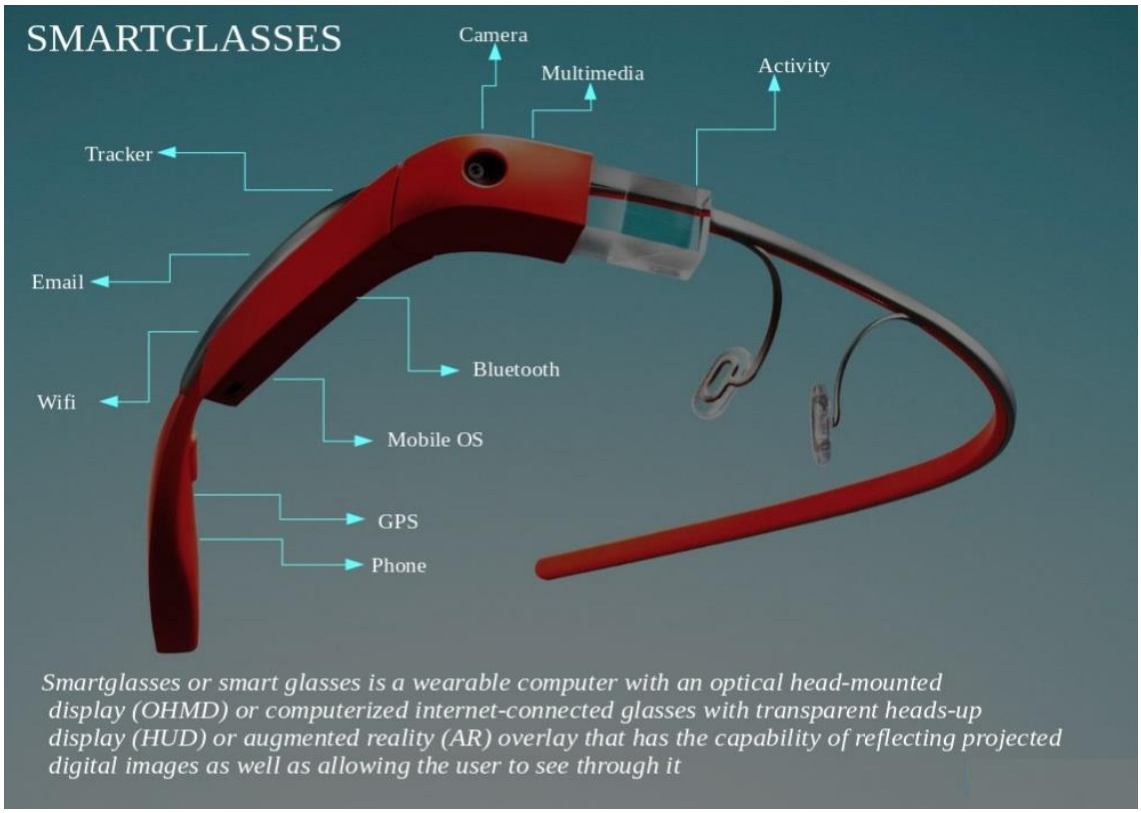
Life Belt is a trans-abdominal wearable device, that monitors the physical health of the pregnant women. Obstetrician and doctors are not willing that patient should visit them frequently. So they monitor their remote health by using life belt. If any complications occur, then it sends alerts to patients and authorities, so they can take quick actions to save both the mother and fetus. Also, Life belt is playing an important role to reduce the load of hospitals. In this way hospitals increase the efficiency and quality of services. (Jamadar 2016.)

Life Jacket

Life jacket is also one of the wearable devices, which is mostly used in the medical field. It helps to check blood pressure or heart rate of wearers frequently. Time to time it transfers all the health information to their medical staff. It also has special kind of camera which captured visual information and transferred all the visual data to physicians which helps them to do proper treatment of their patient. (Jamadar 2016.)

2.3.3 Smart Glasses

One of the most fascinating product which can add information in front of the wearer eyes are the smart glasses. Smart glasses are just like a mini computer, which incorporates high-definition displays of outside world (Pradeep 2013, 3.) These glasses can do everything like our smartphones and tablets. They have internal and external sensors, which can collect data from computer, smartphones and other electronic gadgets. Further, these devices have also wireless connectivity which supports GPS, Wi-Fi and Bluetooth, Picture 3 illustrating the various features of smart glasses Also users can connect internet, and through internet they can do browsing, watch videos and access crucial data on their glass lens. Some smart glasses include, facial recognition software, built-in-cameras, GPS and other applications. If users forget to recognize someone, then they may remember him/her by using facial recognition software. (Schweizer 2014.) In future, smart glasses will change the lives of those, who want new way of communication, need enhanced vision and cope with technological world.



PICTURE 3. Smart Glasses (Wearable Technology, slide 12)

Moreover, with smart glasses, users can take pictures and videos without using their hands. It is the ideal device, where user can capture their personal experiences everywhere and at any time. Also, smart

glasses can take pictures and videos automatically by understanding the body language and expressions of users. (Schweizer 2014.) Further, users can create documentation from smart glasses which can be presented as evidence in courts, filming the crime scene or for personal use. Smart glasses are essential in such situations where user doesn't have enough time to capture the real-time information. For example, at the place of accident, user can show the current condition of place through video streaming.

These glasses have also significant applications on industrial sector. It can be used to take suggestions from the expert at working site by video streaming, when expert is quite far from working place. With the help of smart glasses, expert can see the current situations at work site and give guidance to accomplish the particular task effectively. Further, it can also track eye movement of workers. With the tracking app, the employer can determine that who is tired and needs break or who is not willing to work. To analyse the data from tracking, the employer can improve the productivity. (Schweizer 2014.) Architects are also using smart glasses to find mistakes and prevent possible work hazards at construction sites. For example, these glasses help to avoid incident when worker is drilling holes near sensitive areas, such drainage system, underground pipeline and other.

Smart glasses are also used by blind people to get information of different objects about their surroundings. It is very useful for the blind people to avoid collisions with different things. Deaf people are also using smart glasses to differentiate various voices. It helps to recognize certain voice such as screaming, transportation noise and so on. (Schweizer 2014.)

Moreover, the cinema industry has improved when they introduce smart glasses. Many users prefer smart glasses because they want such entertainment where they are experiencing virtual reality. Also from the smart glasses individuals can introduce subtitles according to their choice of language. By using smart glasses, industry has made a lot of revenue. These glasses are also used for commercial purposes. Shopping malls can give smart glasses to their customers and display information about their products to them. It also helps customers in finding a particular product in less time. (Schweizer 2014.)

Smart glasses are becoming an essential asset of the health care industry. It is useful in such jobs where a computer is not accessible. For example, practitioner can get digital information of patients without accessing computers. It also helps doctors to connect with patients and see their medical reports. Further, patient can contact directly to physicians and receive consultation from him with the help of smart glasses. Moreover, physicians can record clinical information of their patients by using smart glasses.

Currently, many doctors and hospitals are using smart glasses for monitoring and filling electronic records of patients.

Google Glass

Google Glass is a type of wearable device which directly display information to their users' field of vision. It's like an extension of the smartphone screen, where we can access data in front of our lens without holding our smartphones. (Pradeep 2013, 3.) User can send messages, do browsing, take picture and some more tasks with it. It also supports wireless technology such as Wi-Fi, Bluetooth and GPS system. Further, users can run a variety of apps from Google glasses, the same as they can run from smartphones.

Moreover, Google Glass is too soft; therefore, it can easily be damaged or broken. Also, privacy and less battery life are the two main issues in Google Glasses. It has been launched commercially but Google Glass has been banned in many outlets and institutes. Such as casinos, bars, hospitals and banks. It is banned in these places to protect the privacy of others. With the Google Glasses, anyone can secretively take video and pictures of strangers without their knowledge. However, with the face recognition software, someone may find the personal information of the stranger, such as name, contact number, address and so on. Further, in movie theatres, users can record the whole film, without the awareness of the authorities. It's gradually effecting the film privacy. Therefore, authorities strictly announced that it is prohibited to record movie inside the theatre by using Google Glasses. (Gray 2013.)

However, in the school and colleges, Google Glass is banned in lecture halls. Reason being that it helps students to take notes without any effort and record it for their help. To protect the privacy of the patients, it is also banned in the premises of hospitals. Further, it is also forbidden in banks and at ATMs to protect personal information, such as account information and ID of their customer from thieves. Moreover, Google Glasses also unlawful in many other places, such as dressing rooms, sports arenas, locker rooms, concerts and some others. It is clear that Google Glasses have breached privacy and therefore it is banned in several places. (Gray 2013.)

Bruckner Travis

Bruckner Travis is an example of industrial smart glasses which is used for displaying manuals and streaming videos to personnel. It is heavier compared to Google Glasses because all the processing is done in an embedded PC worn in the vest. (Schweizer 2014.)

2.3.4 Smart Shoes

A group of researchers say smart shoes may be the next thing in the busy field of wearable computers and gesture interfaces (LaMonica 2012). Today, the smart shoe industry has adapted new technologies, which have a significant impact on our daily activities. According to the researchers, the next generation of wearable devices have the possibility to be powered by an unlikely energy source. (Palermo 2015.)

Basically, smart shoes are a wearable device of footwear in which the shoes' soles are connected with a smartphone application to get real-time information about the user. These shoes help us to monitor our weight and track exercise. It has also Bluetooth capability which allow users to work on Google Maps to get direction while walking/jogging. (Legend Power 2015.) Further, it also maintains the temperature of our feet and can warm and cold our feet, according to outside temperature. Moreover, one of the successful application of smart shoe is the shoe-sized devices which was built by the German researchers. These devices have the ability to generate power while walking and energy generated can be used to charge electronic sensors and other wearable devices as well. Moreover, the shoes have two devices which are incorporated in their soles and produce power from the movement of the users. One of the device is Swing harvester device which is producing power when the foot is swinging. It means that when our feet are in motion. While other device, shock harvester collects energy when the heel hits the ground. (Palermo 2015.)

The main purpose of developing this device is to generate energy which can power our wearable devices. The energy which is created by the users on daily basic can save electricity from consumer's home. As a result, wearable devices can become independent. (Legend Power 2015.)

Digit Sole

Furthermore, Digit Sole is also an interactive sole which is connected to user's smartphone to track distance travelled, calories consumed and heat intensity on the user's feet. It is sending information from shoes' soles to an app or vice versa with the help of Bluetooth connectivity. Picture 4, shows the functionalities of Digit Sole. Further, with the sole, the users can receive all the tracking information on their app, and also controlling the heat level through their smartphone app. Further, it also sends alerts to the users if heat was not enough according to the environmental temperature. (Borison 2014.)

PICTURE 4. Functionalities of Digit Sole (Dopacio González 2014)

On the other hand, Digit Sole is providing more accurate tracking information of users compared to watches and wristbands. Reason behind that is that Digit Sole can literally track each step and it focuses on every activity accurately. (Borison 2014.)

Self-Lacing Shoe

The Nike HyerAapt 1.0, its first "Self-lacing" shoe, which was unveiled by the Nike Company. It has sensors which helps to tighten the user's lace when it senses the presence of wearer's feet. There are two button on the side of the shoe that helps users to adjust it accordingly. The shoe may provide the more comfortable experience for runners. Further, the shoe will solve pressure and slippage problems, especially for athletes. (Nike 2016.)

2.3.5 Fitness Bands/Trackers

All around the world, there is an increase in the demand of portable devices that can record and capture the person's fitness level. Modern fitness bands are collecting a comprehensive level of data. These devices are tracking every single moment done by the users, such as steps tracking, sleeping pattern, calories burnt, monitoring hear rate, altitudinal changes and so on. Fitness bands are the beneficial devices which allow us to keep moving, helping us to maintain our fitness level and reduce obesity, also motivates us through feedback (Mercola 2016).

Many believes that fitness bands are the perfect way to monitor our daily activities easily with accuracy. Just think, an electronic device on our pulse can record every single moment of the users easily than how device is beneficial for us if users are using on daily basics. (Faulkner 2016.)

Today, various fascinating devices are available in the fitness bands market which are doing a pretty good recording daily activities of the users. Further there is a tremendous amount of data generated from these devices which is not only beneficial for the wearers, but it is also valuable for the corporate companies as well. The insurance companies, advertisement agencies and authorities have got a tremendous amount of benefits by the data collected from the daily activities of the users. This data help companies to known the attitude of users on different things.

Fitbit Charge Hr

Fitbit charge HR is a wearable computing devices which has auto-detect function for tracking exercise activity. This function will automatically monitor the activities of the user, such as in biking and running. This device provides improved pulse tracking information with total accuracy. HR devices is also comfortable in wearing because it has proper watch style strap. Fitbit devices are famous for giving accurate data to users and it is the reason why they have great popularity in the market. (Faulkner 2016.)

Garmin Vivosmart Hr+

Garmin is one of the top growing companies in the wearable industry. Currently Garmin has released Vivosmart HR+ in the market. HR+ has introduced such functions which provide accurate distance, time

and pace tracking with total accuracy. Further it has the Garmin Move IQ auto activity detection software which recognize the user's activities automatically, such as running, swimming, walking and cycling. However, it also has other functions that include activity intensity, touch display, heart rate monitoring and so on. (Thubron 2016.)

Microsoft Band 2

Currently Microsoft band 2 also has great popularity in the market. It is a fashionable and comfortable band. Further it has eleven different sensors which detect various activity of the user. The most important sensor is the barometer sensor which is measuring altitude and track stairs and also hills climbed, while other sensors are skin temperature sensor, gyroscope, heart rate monitoring sensor, galvanic skin response sense, UV sensors and ambient light sensors. This band is very useful for doing different activities, such as running, playing golf, cycling, gym and other sports activity. Generally, it is one more of the powerful wearable devices, in the time for the need of reliability. (Faulkner 2016.)

3 TECHNOLOGICAL AND SOCIAL ASPECTS OF WEARABLE DEVICES

3.1 Application of Wearable Devices

Wearable technology plays a vital role in the daily lives of people as well as of animals. It is used for public safety, anticipating natural disaster, foreseeing diseases, food supply and some other essential issues. In the future, we will see that wearable devices track the movement and activities of various individuals moving around the globe.

3.1.1 Healthcare Application

Researchers from National Science Foundation's Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) at North Carolina State University have created a health and environmental tracker, which is used to prevent and predict the attacks of asthma (Wearable 2016). It has a wristband which consists of sensor devices and is easy to wear for the consumers. There is also a patch which can be placed on the chest. The purpose of the wristband is to track the environmental as well as health characteristics, such as ozone in the air, ambient temperature and humidity, heart rate, motion, percentage of oxygen in the blood and some other aspects. On the other hand, the patch contains such types of sensors which can able to monitor movement of the patients, respirational system, skin impedance, oxygen amount in the blood and so on. (Wearable 2016.)

Nowadays, patients who suffer from asthma also use the peak flow meter to examine proper functioning of lungs daily. However, the health and environmental tracker (HET) is a modified and self-powered spirometer which gives almost exact information about lung functioning and also it has the ability to store the data in it. Further, HET is a low-power wearable device and low-power utilization is essential to increase the battery life. (Wearable 2016.)

Further, researchers at the University of California have designed such wearable device which can observe both electric and biochemical signals. The wearable device comprises with a small electronic board and a set of sensors. It can transfer information from electrical and biochemical signals through Bluetooth technology. (Wearable 2016.)

PICTURE 5. Application of Wearable Devices in Healthcare (O'Neill 2014)

Furthermore, these signals can communicate with smart watches, smart phones or laptops through wireless networks. These types of device are normally placed on the chest of the user to collect enough information. Picture 5 illustrates that how wearable application in healthcare gives great benefits for physicians. It is also helpful for medical doctors to monitor their patients, for instance monitoring the patients who are suffering from heart diseases. (Wearable 2016.)

3.1.2 Business/Purchasing Application

Wearable technology has designed various business applications which have achieved great success in the business sector. It gives a positive impact on business in various ways and in the future, it seems to be an essential source for the business. Organizations can receive and access information about their customers with the help of wearable devices. In the long run, the information helps organization to increase their productivity and enhance customer experience.

Moreover, wearable technology makes the payment process easier and faster. Users can pay for their product and services direct from the smartwatches (Stanley 2014). Smart glasses also have numerous business applications which are very useful in the business world. For example, an employee who is wearing smart glasses can look at a customer and instantly access his/her past purchasing history and

identify their buying habits. They can easily find out the buying behaviour of their customers on particular products about the features, price and reviews. Therefore, we can say that wearables are connecting their users all the time, providing real-time information and make the work easier. (Stanley 2014.)

Wearable technology has been used in commercial ways such as shopping. In the future, there will be shopping applications which helps users to do all the tasks at a single place, such as payment, purchasing, ordering, and information about sales (offers) and so on (Stanley 2014). Further wearable also help merchandizer to find that which products of particular brand is more popular and demandable among consumers. Therefore, they will display and provide offers on those products which are favourable amongst customers. This type of data and strategies allow them to increase the overall sales.

Let's imagine that a consumer is walking in a shopping mall and he/she gets a notification from their wearable devices that there is an item on sale which is one of his/her favourites. Then these notifications will encourage them to look around in the shopping mall. During the time of checkout, consumer will tap their watch towards payment terminal and will get the digital receipt. (Stanley 2014.)

Another, potential idea might be that suppose a customer is walking in a shopping mall, and he/she has a device which is detecting and authenticates their existence. He/she is shopping and looking around in the mall. When he/she has purchased some items, and put them into a trolley then their wearable devices detecting every item one by one and calculating their costs. When he/she finishes their shopping and as they leave the mall, company automatically takes the payment from the card on which they have already registered. Hypothetically, consumers do not have to communicate with anybody, all wearable technology will interact with everything and accomplishing the whole process. (Stanley 2014.)

3.1.3 Pets Tracking Application

Wearable technology is not only for human beings. Users can also use these technologies for their pets as well. From the Figure 1 we can see that the market of pet devices is growing over the period and in 2020 the market will reach nearly $ 250 million. Further, there are various companies who are producing wearable devices only for animals. These gadgets are used to monitor their health and also as trackers through GPS when they are on scavenges.

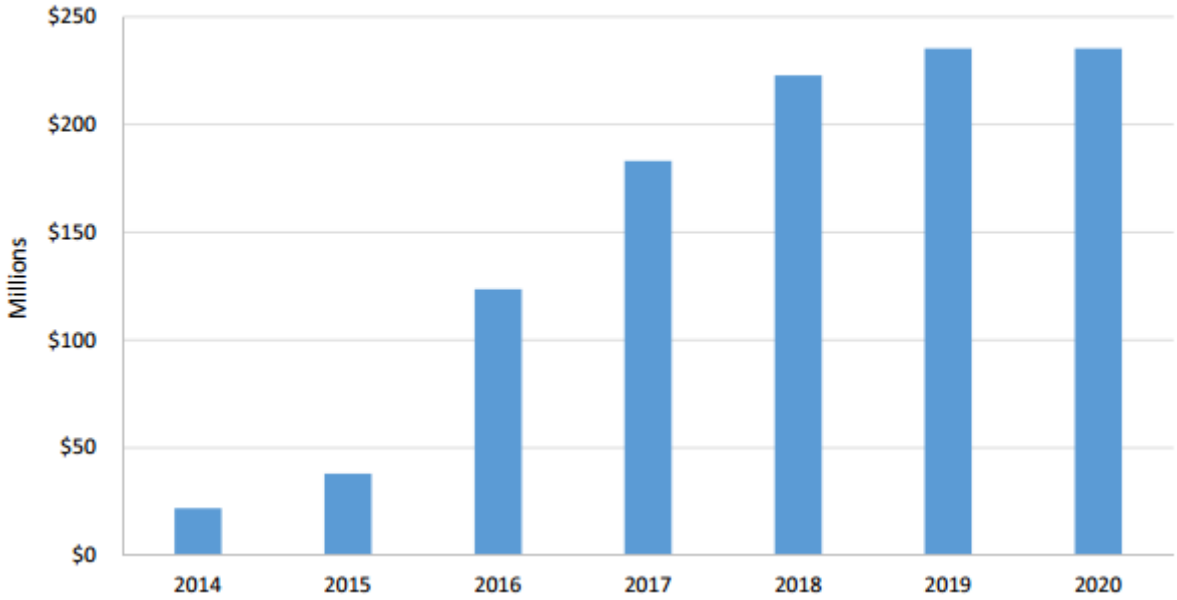


FIGURE 1. Global Market of the Pet Accessories (Hunn 2015,32)

Kyon pet tracker is one of the wearable device which is used to track our pets. It has 3G radio and built-in GPS. It also has waterproof collar which contains a water sensor that detects when our beloved pal is in danger of drowning. Furthermore, owners of the pets will receive alerts on their smart phone from heat sensors when their pet is feeling extremely hot. With the help of ultrasonic buzzer, owners can calm their pets if there is an unnecessary dog brawl. Another important feature is that it also sends the user notifications about the health of their pet and reminds them of the necessary vaccinations. All this information comes to them through this device to their phone and they can also see from the LED screen of the smart collar. (Plummer 2016.)

Moreover, there is a wearable called Inupathy that can tell us about the feelings of our pooch with the help of a doggy heart rate monitor. It is specially designed using the algorithms of canines which fits on as a strap. The main purpose of this device is to find out whether our dog is unhappy, anxious, excited, etc. Owners can observe it when the device is flashing different light patterns and colours. (Plummer 2016.)

Another useful wearable device for pets is Nuzzel. Nuzzel is also one of the smart collar that promises owners to give information about the pet's activities throughout the day. It collects the data by using Bluetooth, GPS and activity tracker and monitors the temperature among other features. It is convenient

for both cats and dogs. Owners can also set up geofence (GPS satellite network) to receive alerts when their pet is on the prowl. (Plummer 2016.)

3.1.4 Smart Clothes Application

Smart clothes are the next phase of wearable technology. In spite of activity trackers and smart watches, smart clothing is becoming popular and already starting to appear in the wearable market. Figure 2 shows that how smart clothing and body sensors are increasing throughout the period. Further it can be seen from the figure that in 2015 the market has started to grow but later, in 2020 there is drastic increase in the market of these devices. This result illustrates that in the future there will be huge demand of wearable clothing and body sensors among consumers. So far, there are various items of smart clothing available which not only record the activities of the users but also help individuals to enhance their health.

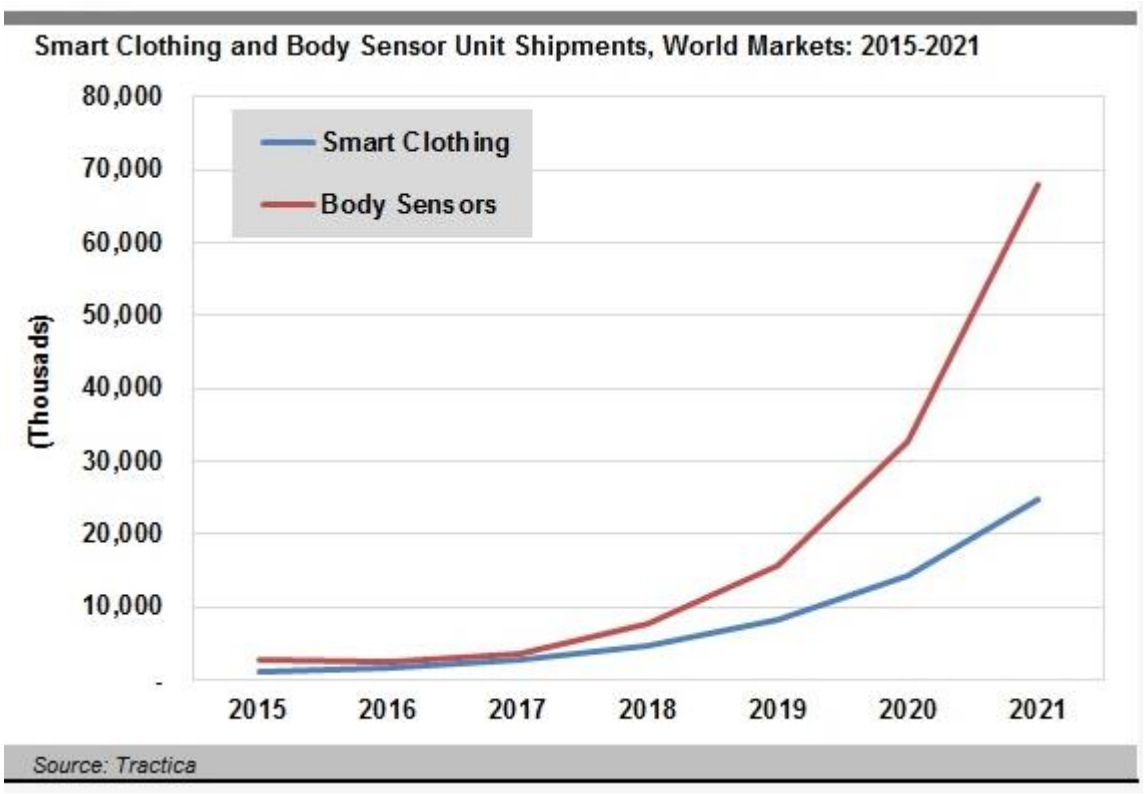


FIGURE 2. Worldwide Shipment of Smart Clothing and Body Sensor in Units (Tractica 2016)

Further, it is easy for us to dress properly according to the weather conditions but it is difficult for those who are working outside in the field. To overcome this problem, wearable technology has provided a

solution. Wearable technology has made such type of smart clothes, which keeps body warm or cold. These devices have various sensitive smart sensors that monitors the outside weather and then maintain the body temperature according the need of the body. These smart clothes are also useful for arm forces, animals, industrial workers, and others as well. Some of the smart clothes applications in daily lives can be seen in Picture 6.

PICTURE 6. Application of Smart Clothing (Wearable technology, slide 15)

A wearable solar garment dress is one of the wearable device which provides continuous connectivity to users, even when they are outside. These types of smart fabric considered as eco-friendly garments that harness the energy from the sun and used it to charge the smart phones, wearable devices and other electronic devices of the users. These devices have tiny solar cells which are interconnected with each other in these smart fabrics. Basically, these solar shirts and dresses are helping to solve battery charging issue which is considered as the one of the biggest challenge in the portable devices. (Daniel 2016.)

Moreover, Smart T-shirt / D shirt is also remarkable wearable device which is created by the French company Cityzen Sciences. Digital shirt (D shirt) has inbuilt devices that includes accelerometer, heart rate monitor, built-in GPS, altitude meter and some other features as well. It has Bluetooth capability that can connect tablets, smart phones and other electronic gadgets to share the user's data for analyses.

Picture 7 shows the features of Smart T-shirt / D shirt. In future, D shirts will use carbon fibre which helps to improve the ECG and heart rate information of the users. On the other hand, Sports teams are the biggest customers of the Cityzen Sciences. Reason behind is that, it is one of the smart shirt which is providing accurate information of players when they are playing and practicing sports activities. Further, the accurate amount of data is not only helpful for the users, but also for the insurance, health, broadcasting companies which increases the demand of these type of devices. (Daniel 2016.)

PICTURE 7. Smart T-shirt / D shirt (Gaurav 2014)

A fashion designer, Ying Gao has created the Move Garment Dress that has goes around the wearer and if someone is staring at the dress then it lights up. Also, it has eye tracking sensors, which can track and detect viewers when staring. However, it also has small electronic circuits which allows users to perform several actions. Subsequently, one of the important feature in this dress is that it starts to brighten in the dark, which helps when crossing the road and going such place where it is completely dark. Its features can also attract audience by illuminations patterns during dancing. (Daniel 2016.)

Owlet Smart Sock is a wireless device which is used to monitor the heart rate and oxygen level of babies, to make sure that babies' pattern of sleeping and breathing will not be interrupted. The smart stock is working on the same pulse oximetry technology which is normally used in the hospitals, because oximetry technology gives accurate figures and it is also safe and proven. The sock is available in three different sizes and can fit snug on the babies' feet. It can also easily be charged through a small base station. Further, base station has its own Wi-Fi which gives alerts by emitting sound and it is also a primary source of alerts system. However, there is also an Owlet app in iPhone and Android which give

continuous update of babies' status through the whole day. It is also called as an extra set of eyes on our babies when there are sleeping. (Owlet 2016.)

Many businesses are investing to make smart clothing for various purpose. One of the extension of smart clothes is the body worn cameras which is becoming lighter and smaller day by day. These cameras are normally used by the police agencies to record unlawful acts. Wolfom is a well-known enterprise which is designing body cameras which serves to doctors, social workers and for those who want to protect their own rights. It is also useful for business purposes as well. With the camera, business experts can record meetings with their clients, observe the customer dealing of employees and also record their daily activities. These videos are also helpful to improve customer services and can solve disputes in the organizations (Stanley 2016.)

3.1.5 Military Applications

Wearable technologies are those types of technologies or gadgets which can help individuals to carry some of their functions more freely. Wearables are providing some form of protection to the individuals when they are wearing such equipment. Wearable devices and displays have significant role in the war and battlefield. These technologies can help pilots to track their foes from long distance. It detects the wind, weather, real-time and evaluates the optimal time of the flight. However, firearms are also using LCD screens to look their target easily instead of traditional scope. Figure 8 shows that how wearable technology is playing a vital role in the battlefield.

PICTURE 8. Smart wearable technology at Battle Field (George 2015)

Armed forces are using smart biosensors for monitoring and sensing injuries of soldiers. The soldier's performance is completely dependent upon their physical conditions. However, there are some other sensors which can be attached on their clothes to monitor the breathing, heart rate and hydrations. On the other hand, wearable technology has established MC10 device, which is sensing head injury in the skullcap. It provides a warning to soldier's, when helmet is starting to weaken. (Skaar 2015.)

Georgia Tech University has developed the FIDO System (facilitating interactions for dogs with occupations) which allows military dogs to use wearable devices to communicate with their handlers. Further, there are various sensors in the wearable device which emits different sound or notifications for the handlers, when dog is tugging, biting and doing other activities. It also alerts their trainer when it detects bombs and other threats. (Skaar 2015.)

Moreover, electronics is becoming as an important part in the battle field and batteries are considered as essential as bullets. But due to the heavy load, soldiers have to put great effort on it. Therefore, BAE system is a global defence, aerospace and security company which has created the Broadsword spine. It is a smart textile device which is integrated into the soldier's clothes. Also, it works as invisible data bank network and also supplying power with help of conductive materials. Broadsword spine is a harness which is incorporated into combat dress (jacket, vest or belt) of soldiers. (Szondy 2016.)

Smart clothes are also valuable for defence forces. They are using these clothes to monitoring vigorous signs and ecological hazards. Further these clothes have wireless communication facility which helps them to give current situation to authorities.

3.1.6 Fitness Applications

Wearable devices for fitness prevent injuries and improves physical activities of users by tracking and viewing accurate information of oxygen level, breathing rate, heart rate and acceleration. Also, professional and home athletes can share their fitness progress with their coaches and friends with the help of Bluetooth connectivity. They also get motivation when they are receiving positive feedback from their colleges and trainers. Picture 9 shows how wearable devices are continuously providing information about user's health.

PICTURE 9. Smart Wearable Technology Application in Fitness (McNamee 2013,4)

Apple Watch Workout

Apple workout is one of the application for the Apple watch and the aim of that app to provide the detailed information of data to users rather than to give general summary. Also, the app will give the user specific modes for cycling, walking and running and will show the real-time information of users. (Alger 2016.)

Garmin Vivosmart

Garmin Vivosmart is a type of activity tracker which has long battery life. It tracks the sleeping pattern, swimming and other various activities of users. It also displays notifications of emails, texts and incoming calls. The OLED screen of tracker shows plenty of data that includes real-time information (time, date and week of days), steps taken, calories burned, distance travelled and other information which helps users to achieve their goals. Further, Vivosmart can also use remote control to perform the specific task, if someone have Garmin's VIRB camera. On the other hand, Vivosmart is considered as one of the best activity tracker, because it can easily make a pair and create a connection with smart phones,

heart and bicycle sensors and any Garmin devices. Also, it provides useful notifications by monitoring the user's environment. (Boxall 2016.)

Runtastic Moment

Runtastic is well known for its remarkable fitness and running apps, but the company has also made classic wearable devices with refined style. Further, Runtastic has introduced fashionable fitness freaks in the world of wearables. It has also LED light and progress bar which displays the user's activities. Further, it can also track the steps taken by the users, sleep pattern, distance travelled and the number of calories burned. However, it is also available in various sizes and styles to suit every taste. (Boxall 2016.)

3.1.7 Safety Application

Wearable technology also allows individuals to use hand-free communication. These wearable devices are essential for professional fields and customer services. Technicians in the field require such type of tool that helps workers to connect them with their experts. Wearable devices like smart glasses and smartwatches support technicians and experts work together and accomplish the tasks effectively, which can be seen in the Picture 10. It also enhances customer service in real-time. (Stanley 2014)

PICTURE 10. Smart Wearable Technology in Industry (Dahad 2015)

Moreover, wearable technology also increases safety among workers. Nowadays, truck drivers are wearing wearable devices to get satellite navigation, which shows direction in front of the drivers. It helps the driver to focus on the road which is eventually essential to reduce number of accidents. (Stanley 2014.)

Further, smart glasses can also be beneficial for the security and police personnel. It not only helps them to record videos for the evidence, but it also has ability of face recognition, which instantly highlights the potential suspects. (Sheehy 2014.)

3.1.8 Corporate Sector Application

Wearable technology plays an important role to reduce the burden on insurance companies. One of the biggest expenditure of insurance companies is processing claims. If users are wearing wearables then these devices will record all the activities of users, which helps insurance companies to identify the real scenario. Adoption of wearable technology is not only useful for the insurance companies but also for the users as well. It reduces the insurance premium and the overall cost of companies. On the other hand, if users refuse to use wearable technology then users have to face higher premium. However, the flip side would be that those who refused to use the technology would face more premiums. (Sheehy 2014.)

3.2 Social Aspects of Wearables

One of the hottest topic in the current technology industry is the wearable technology. Fitness trackers, rings, smart clothes, smart watches and other electronic devices has been already introduced and made great success in the market. Individuals will wear accessories and clothing when it reflects their style. They will surely embrace it when the technology brings meaningful and greater benefits to them. (Kaplan 2015.) When more and more wearables are entering into our lives and also into markets then many questions will be raised regarding privacy risks and potential security. In the past, there were many scientists who did research to solve the privacy issues in wearable devices. But still they didn't succeed well in it. Individuals have shown great concerned about the privacy issues in wearable devices. They know that these devices have potential to store huge amount of personal data in it. If the developer doesn't solve these issues, then it is consequently effecting the purchasing decision of consumers.

Wearable technology will bring a wide range of opportunities in the future which helps consumer's lives in different ways. But without removing the fear of privacy issues in the consumer, it may affect the take-off speed of wearable technology. IoT and wearables are playing an important role to preventative medicine. New technologies, such as smart watches, E-clothes, smart rings and other devices are generating large amounts of data from the user's bodies and transmitting information to our smartphones. Then our physicians are analysing the data and catching things before any disease will come up. (Amyx 2015.)

In the future, we will see how wearable technology can change the medical field. Currently we are in such a phase where we are collecting data. And the next phase will be the data analytics phase where wearables are giving suggestions after analysing the complete data (Amyx 2015). The growth of wearable devices has increased because of the enrichments in technology which supports the electronic and computing devices.

Wearable technology allows individuals to be responsible for their healthier lives, personal finesses and lifestyle. Researchers found that overall individual's health has improved by adopting wearable technology. It can be shown that wearable technology has a huge potential to change the healthcare industry. Currently, these devices have improved the patient's lives concerning heart disease, diabetes and further sicknesses. Following are some areas where wearable technology has been adopted.

3.2.1 Impact on Entertainment, Communication and Media

The entertainment, communication and media industries have a great opportunity for innovation and development in the wearable market. When there is a screen on a device then there is big opportunities for these industries. Millennials are expecting that entertainment and media have more fun and immersive when they are adopting wearable technology. Users are enthusiastic for the wearable devices which are introduced by the media or entertainment companies. (PwC 2014.)

As we know that social media is one of the fundamental mode for the interaction, receiving and share information with others. Therefore, users want to access their social network everywhere at any time by using wearable technology. Users believe that they will receive faster updates from wearable devices as compare to other electronic gadgets and also it is beneficial for the users to receive real-time social

updates and connect with real world with the help of wearable technology. Picture 11 shows how a user of wearable technology is connected with the real world all the time.

PICTURE 11. Wearable Technology Connecting with Social Activities (Mariscal 2014)

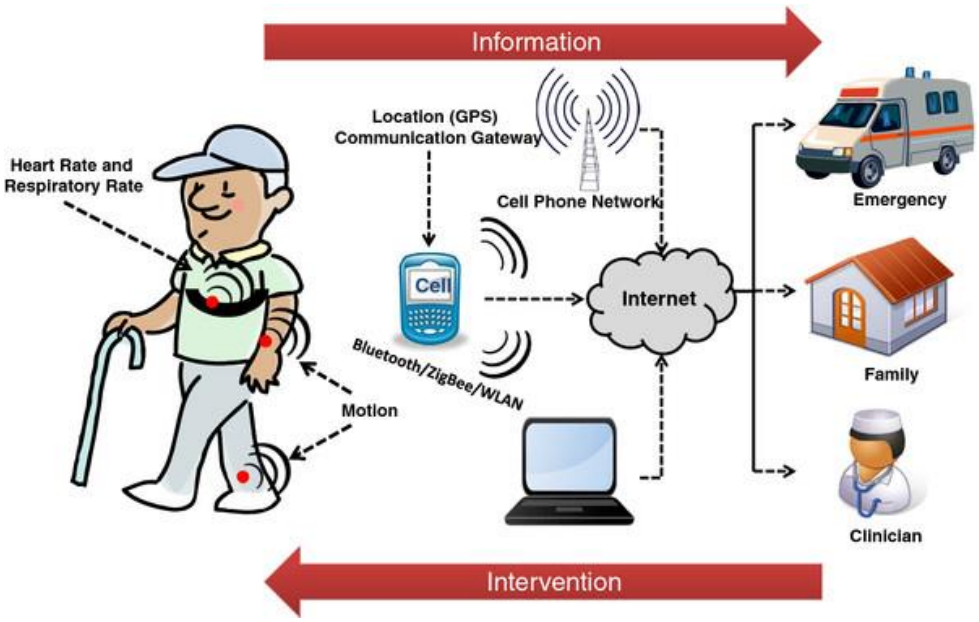
Further, wearable technology is also playing a crucial role in the gaming industry. It can offer new platforms which can change the gaming industry. Fans can play their favourite games anywhere with different wearable devices. Similarly, it also motivates youngsters who have access to play more physically and virtual gaming technology. (PwC 2014.)

Moreover, wearable technology offers new opportunities for media companies for the immersive and relevance experiences, that help to involve viewers by providing relevant information to them. Wearables offer media companies a huge new frontier of relevance and immersive experiences, helping to engage audiences by providing the most relevant content. (PwC 2014.)

3.2.2 Impact on Health and Fitness

Wearable devices have also got great attention over the past ten years in the health industry. It is helpful for the consumers to manage their health costs. Large number of users doesn't embrace wearable technology in health industry but they are willing to adopt it, if wearable technology will make convenient

health care for them. Developers are trying to make such affordable products which is significance for both consumers and healthcare sector. Normally users are willing to get their primary health care data by using wearable technology. Picture 11 indicates that how wearable devices helps users to monitors their health attributes throughout the period. And with the help of wearables and IoT information can be sent to family and authorities, so that they can take actions in the case of emergency.



PICTURE 12. Remote Health Monitoring System Based on Wearable Devices (Patel et al. 2012)

On the other hand, wearable technology will help in renewing the health economy. It also innovates new devices for next generation which should be engaging, interoperable and outcomes-driven. As we know that we can generate crucial health data from the wearable devices, and these data is beneficial for both the employers and insurers to manage overall health care cost of their employees. (PwC 2014.)

The other perspective of wearable devices is that as smart watches, fitness trackers, smart phones and other wearable and electronic devices are frequently emitting radio frequency radiations which may cause many diseases. Experts are suggesting that users should not put any kind of wearable or electronic devices near our brain or our reproductive organs for long period of time. They also signify that we should be careful with the wearable technology, because the bombardment of radiation on us may increase the possibility of cancer. (Bilton 2015.)

We know that cell phones emit radiation at low levels, may cause cancer, brain tumours and others health disease when kept closer to our body for a longer period of time. Then why the well-known companies like Samsung and Apple encouraging individuals to buy these devices that users have to attach these

devices on our body for extended period? The research conducted by World Health Organization (W.H.O), which is that if we put devices away from our body then it becomes less harmful on our health. Therefore, browsing on web or texting is not so much dangerous as compare to making calls. The same way, when Google Glass was introduced in the market then there was serious concern about it. Furthermore, pregnant women should take cautions when using wearable technology. They shouldn't put any wearable which is near to their belly. (PwC 2014.)

3.2.3 Impact on Business and Work Experience

Wearable technology is helping to improve organizational efficiency in general. Developers are designing wearable devices by considering business applications in their minds. One of the essential benefits of wearable technology is that it is makes users more effective and productive at work. Payment processes are also improved and faster through wearable technology.

In the short period, we will see that wearable technology will be an essential part of the retail experience. These devices will provide faster and better retail experiences to their users. However, there is a major concern of users in the wearable devise is the security and privacy issues. Users are generating huge amount of data through wearables, if these issues will not be solved in the future, then popularity of wearables will reduce in the market.

Moreover, a survey was conducted to know the significance of wearable technology among consumers. From the results, 72 % people agreed that wearable technology is essential to improve customer service**.** While seventy-six percent of whom wanted that wearable technology should make shopping more efficient and pleasant for them. (PwC 2014.)

In-store merchandising and promotional disbursements by brands is a key source of funding for retailers. With wearable tech, the marvellous potential for interactions will increasingly expand not only into advertising but also into content marketing, with brands providing content to retailers that will improve the shopping experience. Promotional and advertising activities by brands in a store are a significant source of finance for retailers. With the help of wearable technology, retailers can increase their finance by creating novel method of advertising and marketing. By the similar approach, the shopping experience will also be improved.

According to the research we can see that wearable technology will become more popular and immense in the future. Significant growth in the wearable devise will construct new ways of marketing that includes smarter techniques for advertising, strong data collection of customers and stronger vision by customer's interactions.

Moreover, one of the most popular products of wearable technology, smart glasses, is the cause for the visual confusion. The reason behind is that the device is showing an image which can see by the users from one eye and brain is also focusing on that eye. While there is nothing on the second eye. Due to complete focus on one eye the user is no able to look longer at same object and this problem may cause the visual interference. But some of recent wearable smart glasses have solved this problem of visual confusion because those devices have such smart lenses where users can see from the both eyes.

3.3 Technological issue

Users are willing to use smart wearable system in their daily lives, but they will prefer to study before the actual use of these devices. Normally, wearable devices are working on WSN based system. WSN is the wireless sensor network which has the capability to gather structural and environmental data, such as oxygen level in blood, sugar level, temperature, weight, ECG information, acceleration and others. There is no doubt that WSN based system is very useful, but it is difficult for elderly to understand it. Researchers have found that when geriatric patients fully understand the wearable system then they are accepting it because it is useful and creating minimal disturbance in their normal life. (Chan et al. 2012.)

Further, users are facing various issues when new wearable system are developed. There will be a lack of interest when they are facing difficulties to operate the system correctly. They prefer that the device should be simple to maintain and operate, compact in size and easy in use, so that users do not need any extra help from outside. On the other hand, size and weight are also essential issue in wearable devices. If these systems are not available in decent size, then it is difficult for the users to wear it. Further, the quality of wearable devices is also an essential issue in wearable systems. If these wearable systems are easy to use and give positive contribution to improve user's life, then these devices will become a part of the user's life. Following are some technological issues related to wearables that are faced by consumers as well as companies.

3.3.1 Security and Privacy

Security always used to be a major challenge in wearable devices. From the research, it shows that wearable devices are not fully secure. These devices have a small processor therefore it is hard to apply traditional data security measures. Also, wearable devices are not easy to update because they are not frequently communicating with the internet. Further, there are less mechanism available related to the user authentication in the wearable devices. Anyone can easily access all the information available in wearable devices without any concerns because all the data in the device is stored without PIN protection, security fingerprints or encryption.

Wearable devices are generating and storing huge amount of data in it, therefore one of the key issues in these devices is to securely transfer or storing the data. Security is significant for these devices, as they are containing sensitive information of the users. During processing, devices must be secure, when communicating and storing data from the system and device.

There are various ways to secure the wearable devices from the outside services. The simple and effective way is to use an authorization system, in which the user has to prove his real identity before connecting to the other networks. This method should be intensive and use a different base of authorization. For example, the security needs will decrease when the user is connected with a secure network. But on the other hand, the security requirements will increase if the user is connected with an insecure wireless network, such as private cafes. (Parbhu.)

Further, the data which is stored within the wearable devices is also subject to significant hazards, such as those devices which are storing medical information of the users. Everyone can access the information, if users have lost or misplace the particular device and there is no encryption has been done on that device. Therefore, in that case encryption plays an important role in it because no one can easily access the stored information in it when the data is encrypted. However, users are restricted to put limited security strength on the devices because encryption requires more computational power. (Parbhu.)

Wearable devices have also brought security threats to many companies. Reason being that, there are many employees who are using wearables at their workplaces. These wearable technologies might be powerful enough to steal sensitive information about the company(Reilly.) Moreover, these technological devices have less enterprise security applications which can help organizations to protect their data.

These devices can be hacked with the support of a wearable worn by the employees. Therefore, developers should make such types of devices which have better security mechanism. As wearable technology has the tendency to grow and become more powerful and capable, therefore companies need to be aware with the latest security threats which can be brought in by new wearable devices (Reilly). Also, companies should not allow any employee to wear wearable devices without their consent in the company's premises to protect the privacy in the company.

Wearable technology will bring many advantages to businesses environment when it is used properly in the workplaces. However, businesses also face numerous challenges when they allow employees to use wearable devices at the work place. The significant issue of wearable technology is that anyone can easily record information in wearables without being detected. For that reason, companies are worried of losing their business because confidential information of intellectual property, affairs and finances of the business may leak with the help of wearables devices. (Burke 2014.)

There are various benefits which can be achieved from wearable technology in the healthcare sector. But on the other hand, there are some challenges which can be faced for the protection and sharing of medical information securely. It is difficult to maintain the privacy of data in the wearable devices. If someone breaches the security of smart devices and can take all the financial information of the users, then in that case users can easily cancel their credits cards and close their bank accounts. But when the medical information of user can be accessed by the unauthorized person then it not easy to collect all the storage data again. And, that data can be used to harm the other user. (Ash 2016.)

Wearable technology provides innovative healthcare opportunities which give new ways to healthcare providers to treat their patients. Further, this technology not only reduces health care cost but also improve healthcare outcomes. As wearables are playing a significant role in the health sector but due to the security issues individuals are slow to adopt it. Therefore, manufactures should work on these devices and resolve the security issues to protect individual privacy. And make effective and advanced medical devices which can serve better healthcare all over the world. (Ash 2016.)

Privacy is also one of the biggest barrier in wearable technology. There is also a significate risks of the individual's privacy, during collecting data. Users are underestimating those threats and potentials risks which is involved in the collecting data, because they don't understand the consequences of these risks.

Further, the personal privacy of the users may be in danger when the user has the latest wearable device which can monitor and record every single movement. The reason behind this is that users are accepting the license terms of wearable devices without reading them in detail and allowing developers to share their personal information with other vendors. However, these vendors may not have strong protection network, therefore our private information is now unprotected and can be seen by several digital eyes.

We cannot imagine how small wearable devices can collect excess amount of our personal information, as these devices act as a sidekick. It is true that information generated from the wearables can improve our experiences but when it is hacked/missed than it become harmful for us. When users accept the license agreement then these wearable devices start to collect the personal information of the users. After, the data which is generated from the wearable devices is going to the third party vendors, where vendors are using information to improve their marketing tactics by focusing the daily activities of the users. Furthermore, collection also provides eating and spending habits of the users, which can be used for create new marketing ideas.

When users are wearing wearables, wherever they want, it means that they are somehow de-privatizing their own world and putting their privacy at risk. However, these devices also put others' privacy at risk too. For example, the video recording wearable devices not only records the user's habits but also habits of those within the user's proximity without their consent. Though, Google Glass is banned in public places, especially in bars, casinos, banks and dressing room. The reason behind this is that users can take pictures, record videos and audios without the permission of others. Therefore, many people do not prefer Google Glasses because of the safety, privacy or copyright issues. Therefore, Google decided that they will omit the facial recognition technology in their eyeglasses but still other companies are incorporating these technologies in their wearable devices which have created the conflict between the users and the general public.

Moreover, there also have privacy issues with wearable devices in the situations when it enters an unencrypted network. Wearables such as smartwatches, smart glasses depend on the Wi-Fi connection to accomplish their tasks. Therefore, these devices are automatically connected with the unprotected networks which may cause trouble in the users' privacy.

Wearable technology is growing with a fast pace, which increases the demand of wearable devices in the future. It is always good that new wearable devices with the latest technology will be introduced in the market but at the same time user's privacy should be kept in mind. When improved and new wearables get success in the market then security updates of the current devices momentarily decrease.

Health monitoring wearable devices, such as smartwatches need updated software to perform well and efficiently. But when the advanced version of devices comes out then software developers and manufactures are giving most preferences to recent versions, rather than the previous ones. It means that either the users should buy the latest devices or they may suffer from the privacy and security issues.

3.3.2 Big Data

As we know that wearables are such types of devices which can easily be worn on our body, which includes smartwatches, smart bands, and smart glasses. Also, these devices can easily connect with the mobile devices, the Internet and through other means of connectivity. Therefore, this type of technology has created interesting and diverse applications in various fields. Fitness and wellness, healthcare and medical, industrial, business, military, entertainment and outdoor activities are potential use cases for the wearable technology.

But the question is that how big data can fit into a single puzzle? While this data give users personalized suggestions and recommendations, it is a powerful tool for the marketers. The constant flow of information in the wearable devices requires enormous storage and data processing capabilities. Further, the continuous streaming of data also reduces the speed of the device which creates difficulties for storing and transferring information.

Moreover, big data is also scary because users do not know where the data is going and who is monitoring it. Due to the security and privacy issues it is difficult for the wearables to keep the data safe. Potential challenge in wearables is that the technology does not extend much from the general features such as measuring heart rate, counting steps, tracking and so on. Developers should change these dumb sensors into new gateways, where these gateways can bring new ways which helps users to understand it easily and creates motivation towards new applications.

A tremendous amount of data can be generated from the wearable devices and that data can be used and examined in different ways. But the great challenge is that this data is not systematic, therefore it is difficult to manage, utilize and store and it is also not much useful for the users as well. Thus, developers should apply advanced techniques to create analytical platforms for these types of data, so it can be understandable and used to improve user's performance.

3.3.3 Limited Battery Life

Wearable devices are fascinating and have great potential in the future. But still it owns significant drawbacks which has slowed down their growth in the market. Of those weaknesses, one of the most crucial is the limited battery life. Usually, devices require eight to twelve hours charging which is normal, but when it comes to wearables then it has less battery life compared to other devices. Therefore, it is essential for the developers to solve this critical problem in order to maintain the popularity of wearable devices in the market. (Delgado 2015.)

Many think that the battery life problem is common in every electronic device, then why does it become a critical problem for wearable devices and how can it reduce the take-off speed of wearables? The reason behind this is that wearables are only useful when they are small and light, so that users can wear them easily. But to make it small and light, developers have to reduce the size of batteries and that can create battery life issue in wearables. Further, users have to recharge more often because of small batteries and which is not so simple in the case of wearables. For example, medical devices are constantly working and collecting essential data of the patients. If these devices have to charge after every few hours, then it is hard to continuously monitor user information. Thus, it is essential that battery life in wearable should be improved to make devices more convenient, easier and increases the overall life of wearables. Energy efficient techniques is also required for the wearables to get better performance and duration.

The other challenge in wearable electronics is that, which is the most effective way to charge the batteries in wearables? Charging that involves wires are not easy when it comes to wearables. Therefore, one of the efficient approach is energy harvesting. Energy harvesting is that where we can charge our electronic from the heat, ambient light or movement. This technology is already developed but it is not so much common in wearables. Therefore, it is the perfect tactic to charge batteries even though directly when wearables are worn on the body. Thus, inventors should overcome such formidable challenge to make wearables as staple in everyone's life. (Delgado 2015.)

Physical size and battery limitations are two of the challenges faced by wearable devices in the market. Batteries require comparably large space in the device, which is difficult for the developers. That's a reason which may impact on the type and quality of display use in wearable device. Therefore, it is one of the critical challenge for the developer to fix the battery in a small space. If the battery size is bigger than the device looks like bulkier and bigger and then less people prefer to wear it.

However, to overcome that problem, some wearable producer designed the device without screen or with screen with low power, because display will use large amount of battery, especially in wearable devices. By doing that they are making effective device with an enough battery life. But still users prefer powerful battery life with a large size of display. Therefore, developer have to solve the display issue and improve the battery life time, if they want wearables to capture the market and achieve great success.

3.3.4 Standardization

Moreover, the wearable industry is facing its biggest challenges because there is lack of standardization in wearable devices. There is no standardized platform for both the hardware and software, power codes and effective ways of charging wearables devices, which creates lack of interest and trust among users. Also, it is critical to coordinate among wearables, when no specific standard is given. Users will face lots of difficulties when they are transferring files from one wearable to other. Reason for this is that both wearables might have different application platform which creates hurdles in transferring data. Lack of standardization in wearable devices creates a gap which will not allow users to meet anticipated and current needs. Thus, there is collaboration required between the enterprise developers and wearable designers to make a standardized platform, to solve the challenges faced by the users.

3.3.5 Interoperability

Interoperability is also a critical challenge for wearable technology. For example, the data generated by healthcare is very basic, but it is difficult to transfer the data from/to smart phones and other electronic devices because wearables and other electronic devices have different applications. In that case, wearable technology acts individually, it does not have standardization among other wearables. Also, integrated data of patients which is generated from the wearables devices faces problems to access data from traditional applications. Therefore, developers have created such software platform in wearable devices so that it can exchange functions and information in desktop and mobile devices. (Gough 2015.)

3.3.6 Hardware and Software

Another challenge for wearables is the overall weight of the device. If weight of the device is not comfortable than users lose interest in the wearable devices. Also, material used in the wearable devices is essential. Users are wearing these devices for a prolonged period of time to generate data that may cause skin disease for the users. Many times, it has happened that the user with sensitive skin developed rashes on their body. Therefore, developer should use metallic or non-metallic substances which may not provide harm to users' body.

As we know that wearables are developed to provide faster interaction but when software and hardware fail in providing high level of consistency then fragmentation take place in it. And developer is offering limited number of hardware and software combinations in the market which continuously effecting the image of wearable devices. (Chan et al. 2012.)

4 BUSINESS ASPECTS OF WEARABLE DEVICES

4.1 Companies

Nowadays, wearable technology is one of the most exciting technological trends in the consumer market. It has been growing from many decades and had got great success in every field by improving users' daily lives. I have analysed various companies which have made big waves in the world of wearables. Following are several famous companies described below:

4.1.1 Apple

> Apple Inc. (Apple), incorporated on January 3, 1977, designs, manufactures and markets mobile communication and media devices, personal computers and portable digital music players and sells a variety of related software, services, peripherals, networking solutions and third-party digital content and applications. The Company's products and services include iPhone, iPad, Mac, iPod, Apple TV, a portfolio of consumer and professional software applications, the iOS and OS X operating systems, iCloud and a variety of accessory, service and support offerings. (Reuters 2016.)

Apple is one of the major players in the wearable technology among other competitors. Apple has officially launched their first smartwatch on April 24, 2015 to nine countries which included United States of America, United Kingdom, Germany, Australia, China, Canada, Hong Kong, Japan and France. The earlier watch introduced the revolutionary technology named Digital Crown and the use of Retina Display further enhanced the opportunity to the end user to be able to get quick and easy way of access controls. Furthermore, the company has launched series of their smartwatches from Apple Watch Series 1, Apple Watch Edition, Apple Watch Hermes, Apple Watch Nike+ and the latest Apple Watch Series 2. (Bessette.)

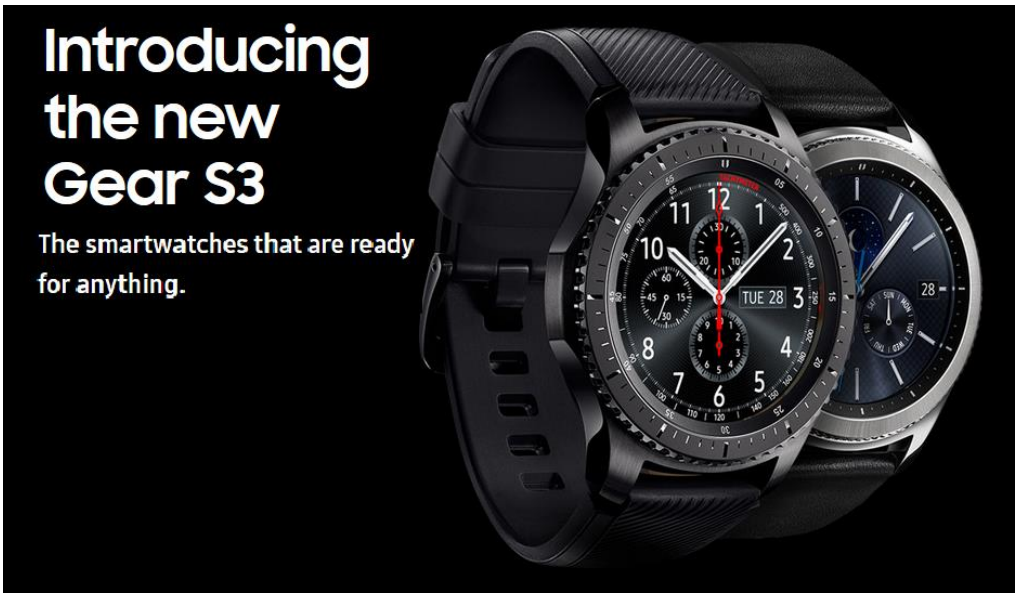
Moreover, on September 7, 2016, Apple launched its second series of wearable technology watches named as Apple Watch Series 2 (shown in Picture 13) and introduced as the world's most popular devices. Apple has installed better tech capabilities which included the latest fitness and health competences, water resistance and a built-in GPS which removes the necessity of using the iPhone. The watch also features better display and a powerful processor named dual-core processor to run applications more quickly. (Bessette.)

PICTURE 13. Apple Watch Series 2 (Garcia 2016)

4.1.2 Samsung Electronics

> Samsung Electronics Co., Ltd. is mainly engaged in the production of consumer electronic products. It operates in three business divisions: consumer electronics (CE) division, which involves in the color televisions (CTVs), monitors, printers, air conditioners, refrigerators, laundry machines and others; information technology & mobile communications (IM) division, which involves in the production of computers, handhold phones (HHPs), network systems, digital cameras and others, as well as device solutions (DM) division, which is divided into semiconductor and display business parts, providing dynamic random access memories (DRAMs), flashes, thin film transistor-liquid crystal displays (TFT-LCDs) and others. The Company distributes its products within domestic market and to overseas markets. (Reuters 2016.)

Samsung is also one of the major competitor of wearable technology as Android has more users than the Apple. Samsung also has deep footprints, as Samsung was included in those companies which had introduced strong smartwatch choices to the users in the wearable technology industry. Earlier Samsung has introduced the Gear 2 watches which enabled the user to access all the notifications and applications being majorly dependent on the touch screen option. (Paredes 2016.) Followed by the release of second series of Apple smartwatches, Samsung has launched Samsung Gear S3 watches which can be compatible to all Android phones, along with the latest Internet connectivity 4G LTE which is only available in Samsung Gear S3 watches as claimed by the company. This watch has also retained the IP68 rating which means that the watch is water resistant up to 30 minutes with up to five feet of water. (Samsung.) Picture 14 illustrates the functionalities of Samsung Gear S3.



PICTURE 14. Samsung Gear S3 (Samsung)

4.1.3 Fitbit

> Fitbit, Inc., incorporated on March 26, 2007, is a provider of health and fitness devices. The Company's platform combines connected health and fitness devices with software and services, including an online dashboard and mobile applications, data analytics, motivational and social tools, personalized insights and virtual coaching through customized fitness plans and interactive workouts. Its core platform includes over eight wearable connected health and fitness trackers. It offers various fitness devices, including Fitbit Zip, Fitbit One, Fitbit Flex, Fitbit Charge, Fitbit Blaze, Fitbit Charge HR, Fitbit Surge and Aria. Its platform includes wearable connected health and fitness trackers, which are wrist-based and clippable devices that automatically track users' daily steps, calories burned, distance travelled, and active minutes and display real-time feedback. The Company's trackers also measure sleep duration and quality. Its products track heart rate and global positioning system (GPS)-based information, such as speed, distance and exercise routes. In addition, it offers a wireless fidelity (Wi-Fi) connected scale that records weight, body fat and body mass index (BMI). (Reuter, 2016)

Fitbit is also playing a major role in providing the wearable devices to the consumers who use these products in their daily life. The recent example could be the case of a patient's life threating condition that has been diagnosed by using the Fitbit wrist band. The doctors have used the patient tracking history from the device and identified when the patient's heart beast has jumped from 70 up to 190.

Further these Fitbit devices also provides an opportunity to the emergency services with some valuable clinical information before the patient arrives at the emergency department. (Bratskeir 2016.)

The Fitbit has introduced the latest Fitbit Flex 2. As per the company information on the products section Fitbit Flex 2 is one of the slimmest wrist band they have ever produced and fitted with the removable tracker which can be seen in the Picture 15. The standout features in the latest Fitbit Flex 2 is swim proof, swimming tracking, interchangeable accessories, call and text notifications, smart track (auto exercise recognition) and reminders to move. It also provides the long battery life up to 5 days under certain conditions. (Fitbit.)

PICTURE 15. Fitbit Flex 2 (Fitbit)

4.1.4 Huawei

> Huawei's products and services are available in more than 170 countries, and are used by a third of the world's population, ranking third in the world in mobile phone shipments in 2015. Sixteen R&D centers have been set up in the United States, Germany, Sweden, Russia, India, and China. Huawei Consumer BG is one of Huawei's three business units and covers smartphones, PC and tablets, Wearables and cloud services, etc. Huawei's global network is built on 20 years of expertise in the telecom industry and is dedicated to delivering the latest technological advances to consumers around the world. (Huawei.)

Compared with other wearable companies in the industry, Huawei, a Chinese company, is in early stages in developing an anticipated brand outside of its territory. Huawei is aiming to become the first genuine

smartwatch to compete with Google. The use of leather and the hard glass enables the product to be very far ahead of other models. The product is supported by Android, hence all the application features of the Google are accessible, however the company has additionally fitted with daily tracking application. (Lamkin 2015.) Furthermore, Huawei products do not include the GPS (Huawei) which makes them less attractive to the consumers compared to other wearables available in the industry. Moreover, TalkBand B3 is the latest model of the Huawei. It is the next generation of wearable devices. The design of the Talkband B3 keeps users connected in style anytime and anyplace. Further it has a headset which is secured with a powerful magnetic lock. The product is supported by Android; therefore, all the application features of Google are accessible. (Huawei.) Picture 16 illustrates the latest functionalities of Huawei TalkBand B3.

PICTURE 16. Huawei Talk Band B3 (Huawei)

4.1.5 Polar

In 1975, the idea of portable heart rate monitors came into existence on a skiing track. At that time there was no way to accurately record heart rates during training. Just over a year later POLAR Ltd was founded, near the city of Oulu, Finland – a region renowned for its technological research and surrounded by some of the most challenging environments in Europe. The area was quickly identified as the perfect setting to test the company's pioneering equipment to its limits. Moreover, in 1979 POLAR filed its first patent for wireless heart rate measurement and in 1982, launched the first ever wire-free wearable heart rate monitor, changing the way athletes trained forever. Now, over 30 years after that first moment of inspiration, POLAR provides the most comprehensive product range in the industry. From basic models that help motivate and inform beginners and regular exercisers, to providing complete training systems for world champions across numerous disciplines. (Polar.)

Polar is one of the popular brands which has got great success in wearable technology. It is the first company who offered the activity trackers with heart rate monitor. Further, Polar is a big deal in the business of smartwatches. Moreover, Polar, a Finnish company, introduced Polar M600 which is the first Android wearable devices that blurred the lines between activity tracking and a smartwatch. It has its own dedicated fitness app, GPS and GLONASS which can be seen in Picture 17. Also, it is waterproof with IPX8 certification (so is safe for swimming) and has a rugged silicon band making it perfect for sports people. Polar M600 is designed to suit the active lifestyle of users. (Lamkin 2016)

PICTURE 17. Polar M600 (Polar)

4.2 Current Analysis of Wearable Technology in The World

The consumer electronics market has convinced itself that wearable technology will be the next big thing in the electronic industry. Experts believe that the wave of wearable technology has potential which can replace current electronic gadgets with wearable computing devices. The overall trend of wearables devices is significantly increasing over the period of time. In 2020, the market of wearable computing devices will reach around $ 95 billion, which will be drastically increased in the wearables technology in every field of life (I-Micronews 2015.) And it is predicted that the fitness trackers will be most popular wearables among users. Moreover, in 2015 the consumption of sports/activity fitness activity tracker by volume was 57.2 million which is highest consumption among others (Raconteur.) and North America was the regions where the maximum number of wearables were sold (Statista 2016).

The overall market size of wearable technology was estimated over 18 billion USD, in 2014, which shows that there was rapid adaptation of wearable devices all over the world. Increasing population and consumer awareness are the drivers which help wearable technology to achieve maximum growth in the future. Further it is anticipated that Internet mobility and smart phone penetration will fuel wearable industry over a couple of years. Also, the wearable technology market may get favour from the lifestyle of urbans, which encourages users to get consumer utilities from wearable devices. However, the privacy and security issues is one of the significant challenge in wearables which may affect the growth of wearable technology in the next few years. High cost and low battery life are also hurdles for wearable industry. (Grand View 2016.)

Wearable industry has severed in various sectors such as sports and fitness, healthcare and medical, industrial, arm forces and business sectors. However, continuously need of health monitoring is one of the factor which will increase the demand of health care applications in the next seven to eight years. Subsequently sports and fitness devices are normally used to track all the activities done by the users. In 2014, the fitness and wellness sector contributed more than 28% market share in the overall revenue of the wearable technology. And in the next seven to eight years it is estimated to grow around 35% with the compound annual growth rate (CAGR). Additionally, users can wear wearable products on any part of the body depending upon the functionalities required by the users. However, wrist-wear considered as the key segmentation of wearable products and it is device which have added over 45% of overall revenue in 2014. Further research shows that 15% share of the eye-wear products have contributed in the overall revenue of wearable technology in 2014, which is less as compare to wrist-wear. (Grand View 2016.)

According to regional insights, the wearable technology market of North America is considered as a key regional segment in the health consciousness and wearable products usage. It is one of the largest users of wearable technology due to various factors. One of the essential factor is the technological advancements and innovations, which allows to introduces new products in the market. Further, the region has added over 49% of overall revenue share and it is expected to increase by 32% from 2015 to 2022 at a CAGR. On the other hand, manufactures have also planned to shift their productions to Asian Pacific region because of the low operation and labour cost. Therefore, it is expected that in the next seven to eight years the Asian Pacific market will achieve significant growth in wearable technology. (Grand View 2016.)

Furthermore, the driving force for the growth of wearable markets is comprised of the popularity of smart watches and wrist bands in the electronics market. Integrated consumer wearables and popularity of IoT (Internet of things) also play a significant role in the growth of wearable market. Moreover, in the consumer electronics sector the growth of wearable technology is mainly contributed by demand of wearable computing and wearable scanners. The consumer wearable devices provide various applications for users in sports and fitness, fashion and garments and multimedia and entertainment. Other electronic devices such as smart trackers and wristwatches are used to monitor the physical activities of the users. (Rohan 2015.)

However, in the future, the popularity of wrist wearables devices will also take off among other wearables. Apple and Samsung both are the leading companies which have achieved great success when they launched their wrist bands and smartwatches in the market. Though Fitbit, Nike and Adidas are also famous for their computing devices. Further, various aspects are explained to analyse the wearable market from a different perspective.

4.2.1 Wearable Application Breakdown

Wearable devices are one of the hottest topics in the consumer market these days. It is providing useful information to users in a most friendly and natural way as compared with traditional electronic devices. Consumer, healthcare and industrial are three markets which will be the driving force of wearable technology in the future. The overall trend of wearable applications has significantly increased over the period. It is estimated from the Figure 3 that the wearable industry will reach 295M units by 2020, with a market value of 95B.

Moreover, in 2013, the healthcare application was the main driven force for the wearable market with 10M unites, but from the 2014 onwards consumer products have also shown great potential to lead the market. One of the possible reason could be that consumers will be more conscious about their fitness, so that they will embrace more fitness bands and smart watches in order to maintain their fitness activities. Also, it can be assumed that a large part of the healthcare market will evolve in association with the consumer market.

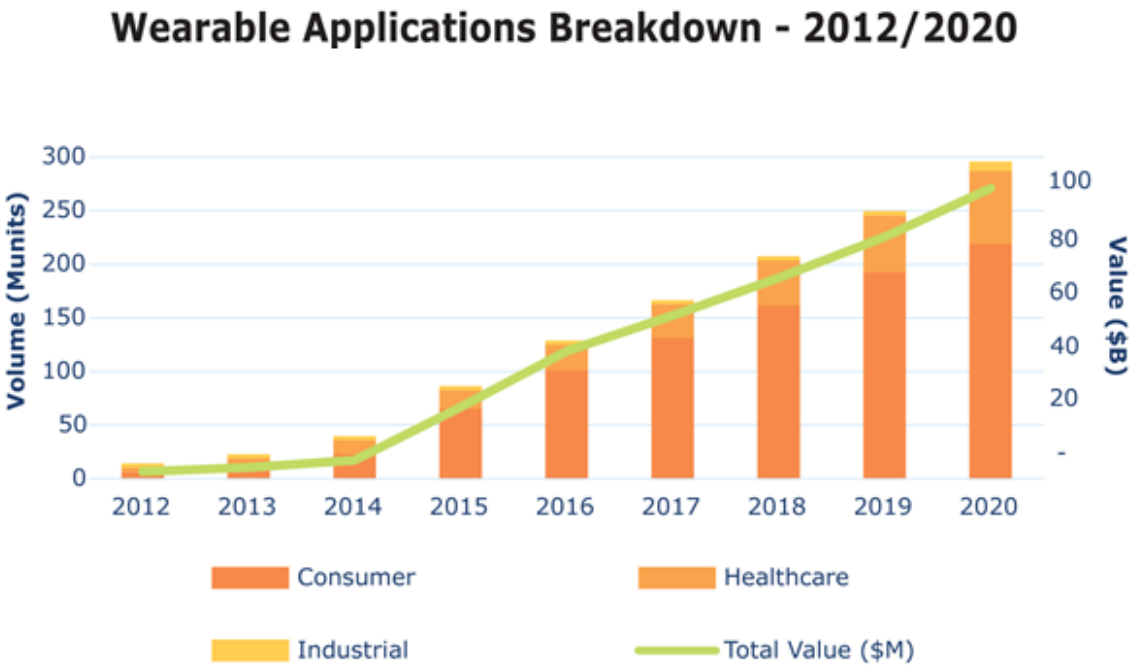


FIGURE 3. Wearable Application Breakdown 2012./2020 (I-Micronews 2015)

Further, the market of wearable technology is still in the initial stage as far as it concerns the industrial sector. The reason is that there are very few products which are reliable and effective in that sector. The industrial market will be constant throughout the period but it will significantly increase in the beginning of 2020. It can be expected that there will be more applications available in 2020, which will increase the growth of wearable devices in the industrial sector. However, the healthcare market is slightly increasing throughout the period, but it will expand in 2020, which shows that more wearable devices will be used in healthcare sector for various purposes compared to others in preceding years. As it can be seen from the figure, the future consumer wearable products will lead the market by providing a variety of wearable devices.

4.2.2 Wearable Device Unit Sales Worldwide by Regions

Wearable technology is considered as big business in terms of sales in various parts of world. According to the statistics given in Table 1, 38.65 million wearable devices were sold in the North America, which is the highest sales amount in all the regions in 2015. While in 2020, the sale will reach up to 180.96 million which shows that there will be drastic consumption of wearable in that region.

TABLE 1. Wearable Device Unit Sales Worldwide by Region in 2015 And 2020 (Statista 2016)

Worldwide Regions	**Unit Sales in 2015 (Millions)**	**Unit Sales in 2020 (Millions)**
Asian Pacific	30.4	194.67
Central and Eastern Europe	5	45.85
Latin America	1.83	26.08
Middle East and Africa	4.09	25.42
North America	38.65	180.96
Western Europe	16.75	127.64

Moreover, the researchers have expected that in 2020 the Asian Pacific will be the region where maximum number of wearables will be sold. The reason could be that the Asian Pacific will be the most developed regions where people will consume more wearable devices as compared to other regions. From the given data, it can be considered that people in Latin America are not so much familiar with the wearable technology because only 1.83 million units were sold in that region in 2015 which is lowest among all regions.

Furthermore, it is clear from the data that Asian Pacific and North America are the only regions where there was a high demand of wearable devices in 2015, however the demand of wearable computing devices was slightly less in Western Europe compared to both regions mentioned above. But in 2020, Western Europe will be one of the regions where large number of wearables will be sold. Therefore, it is shown from the statistics that in 2020 more than 0.5 billion wearables will be used within three regions i.e. Asian Pacific, North America and Western Europe while only 97.35 million wearables will be sold in the rest of the regions. Thus, it is concluded that wearable technology has an enormous demand in the future, which will bring the dramatic increase in the sales of wearable devices all over the world.

4.2.3 Wearables Usage by Volume in Years

The rapid growth of wearable technology products encourages youngster to embrace wearable devices in their daily activities. In fact, innovation in wearables devices brings more advancements in wearable technology in the future with unlimited possibilities for consumers. Medical professionals, businesses and military forces have been using wearable technology for decades, but the private consumer market

has recently started to feature items such as wearable cameras, sports/activity fitness trackers, smart glasses, smart watches and others. The Table 2 shows the usage in volume of five most popular wearables for year 2013, 2014 and 2015. Overall, it is indicating from the figures that demand of wearable devices has increased over the period of time

Year	**Wearable cameras**	**Sports/Activity fitness trackers**	**Smart glasses**	**Smart watches**	**Healthcare wearable**
2013	6.6	32.5	0	1.2	13.5
2014	13.6	42.6	2.1	7.4	22.6
2015	15.8	57.4	10.5	24.9	34.3

TABLE 2. Wearable Consumption by Volume in Years [millions] (Raconteur)

In 2013, the most consumed wearable device was the sports/activity fitness tracker which has the highest consumption by volume which is 32.5 million. However, in the same year the usage of other wearable devices such as healthcare wearables, smart watches and wearable cameras are 13.5,1.2 and 6.6 respectively which are much less compared to fitness trackers. Primary reason for the higher consumption in sports tracker could be that people care more about their health and fitness.

Moreover, the consumption of smart glasses was negligible in year 2013, because these technologies were not completely developed in that year as Google glass was first time available to the public on May 15, 2014. On the other hand, there was significant increase in the consumption of sports/activity fitness tracker in 2015 as compare to other wearable devices. Also the usage of healthcare devices has also increased throughout the year which is 22.6 million in 2014 and 34.3 million in 2015.

Another interesting fact could be seen from the above table related to the dramatic increase in the consumption of smart glasses and smart watches in year 2015. One of the reason could be, Goggle Glass was launched in wearable market in 2014 and it was so popular that it attracted many consumers. In the case of smartwatches, the reason could be that, the year 2014 was known as year of wearable devices, after that year many big companies like Apple, Samsung and other started making smart watches with more advance features and it is easily available to the consumer. However, in 2014 there was also increase in the consumption of smart cameras which was two times higher than the previous year.

Therefore, it is concluded that the consumption of wearable technology of all the popular devices increased throughout the year. But the Sports/Activity fitness tracker and healthcare devices were the most preferable among consumers.

4.2.4 Market Share and Shipments of top Five Wearables Vendors

When wearable devices came to the lead of the technology market, experts believed that these devices will soon be a part of everyday life of consumers. Today, we can experience how wearable gadgets are providing useful information to their users in a natural way and are becoming a part of their lives. Further, there were various wearable vendors available in the consumer's market but the top five vendors had greatest influence in the market in year 2015 and 2014.

TABLE 3. Top Five Wearable Vendors, Shipment Market-Share and Year-Over-Year Growth 2015: Units in Millions (Statt 2016)

Vendor	**2015 unit shipments**	**2015 market share**	**2014 unit shipments**	**2014 market share**	**Year-over-year growth**
1.Fitbit	21.0	26.9%	10.9	37.9%	93.2%
2.Xiaomi	12.0	15.4%	1.1	4.0%	951.8%
3.Apple	11.6	14.9%	0.0	0.0%	Na
4.Garmin	3.3	4.2%	2.0	7.1%	60.9%
5.Samsung	3.1	4.0%	2.7	9.2%	18.5%
Others	27.0	34.5%	12.0	41.9%	124.0%
Total	78.1	100 %	28.8	100 %	171.6%

The Table 3 illustrates the market share and shipment units of top five wearable vendors such as Fitbit, Xiaomi, Apple, Garmin and Samsung in the year 2014 and 2015. From the table, it can see that Apple came in third place on the industry, just behind Xiaomi, however Fitbit is still far ahead of all the technological companies and become leader in 2015 with 21 million shipments.

However, in 2015, the overall shipment of global wearable devices reached 78.1 million, which increased by 171.5% as compared to previous year. From the past year, wearable technology maintains

the high growth rate and in the future, it will continue to maintain it. Further wearables can also increase their market share in the overall electronics market.

From the figures, it can be seen that Apple have created a great image in the wearable market in the year 2015 and ranked as third most preferable wearable device manufacturer. Also, the shipment of Apple devices has increased dramatically in the year 2015 which is 11.6 million.

On the other hand, Fitbit is still the market leader in the wearable devices, which acquired 26.9% share in the global wearable market in 2015. However, in the same year, the market share of Fitbit was decreased by 11% as compared in the year of 2014. Further, Xioami the Chinese wearable company has increased their market share by 11.4% in 2015 and it is significantly growing in the wearable market. However, Samsung and Garmin have also contributed to increase the overall shipment of wearable devices. But they both have lost their market share in 2015.

Thus, result shown that in the year 2015, the shipment of global wearable devices has increased by the 171.6% as compare to the preceding year which is evidence that there is a substantial growth in global wearable device market.

4.2.5 Comparison of Wearable from Excitement Vs Trust Perspective

Wearable technology offers great opportunities to their consumers and day by day men and women are getting excited by experiencing wearable technology products. The below Table 4 has explained the relationship between the excitements for adopting wearable devices and trust on these products.

TABLE 4. Comparison of Wearable from Excitement Vs Trust Perspective (PwC.9)

Applications/ sectors	**% of Excitement**	**% of Trust**
Doctor's office	65%	41%
Hospital	62%	38%
Health insurance company	62%	34%
Cell-phone provider	61%	18%
Entertainment provider	57%	10%
Pharmacy	57%	29%
Teacher	57%	12%
Travel agent	56%	8%
Cable provider	52%	11%
Bank	52%	33%
Car company	50%	9%

It can be seen that consumers' excitement and consumers trust on wearable technology are not always the same. The reason behind is that when technology is in the emerging phase, then users have many expectations from the technology, therefore they are really excited to adopt it. But the excitement on anything doesn't means that users rely or trust it. Trust will only be created when there is less security and privacy issues and product is reliable for the individuals.

According to the research, it shows that wearable technology has played a significant role in the healthcare sector. It has provided various ways to improve health and fitness which is beneficial and reliable for the users. Therefore, the trust in the health sector is much higher than the other areas. Further, users are also excited about the wearable technological products which is used in the automaker, cable provider and bank sectors. In the meanwhile, Millennials are also enthusiastic to adopt the devices which is produced by the entertainment, education and cell phone providers.

But the greater consumer excitement does not mean that there is always the same correlation of consumer trust as well. As we can see that, the consumer's excitement of cell phone provider is higher than the bank, while the customer trust is 200 times lower than the bank.

Overall, it is concluded that the consumers have more trust on the health providers rather than the other providers. However, resolving trust issue among millennials is only possible, when providers will offer wearable devices where it will be easy to use and the data will be secure in it.

5 SURVEY ON CONSUMER PERSPECTIVE OF WEARABLE DEVICES IN FINLAND

Nowadays, wearable technology shows the popular emerging trends of the consumer market in Finland. Usually consumers prefer those wearable devices, which have innovative functionalities so that it can provide diverse services to them and make their life better and easier.

To know about the viewpoint of users on wearable technology, I have conducted a survey that shows consumer perspective of wearable devices in Finland. I have gathered around 400 samples from various regions in Finland. Those samples contain various questions about wearable technology and its potential usage in Finland from different aspects. Most of the samples were collected from the three main region of Finland, i.e. Lapland, Oulu and Helsinki regions.

Further, this survey was conducted in both the Finnish and English languages. Majority of the questions were asked from university students, researchers and technical employers. From the results of the survey, it is observed that many people are willing to adopt various wearables in their lives to make things easier. Many of the university students were already familiar with the popular wearables such as smartwatches, fitness bands and smart clothes. However, the older people were less informed about the recent wearables technology. I have given the detail analysis of each of the questions in coming sections. I have analysed that this survey study is not just valuable addition to find consumer viewpoint on wearables but at the same time, it is useful for the wearable companies in Finland to know what exactly the users want. With the help of this survey, companies can determine the current most demanding wearables in Finland and based on the results, they can focus on particular age groups having higher demands.

5.1 Popularity of Wearable Devices in Finland

The wearable market in Finland is still in the emerging stage and to find the popularity of wearable devices in Finland, the following question were asked from Finnish people.

Which wearable are you currently using/ willing to use?

a. Fitness Band
b. Smart Watch

c. Smart Clothing
d. Smart Glasses
e. People tracking device/ Pet tracking device
f. Other, Specify

TABLE 5. Current Most Wearable Devices Used in Finland

Types of Wearable Devices	**Percentage**
Fitness Band	34%
Smart Watch	31%
Smart Clothing	10%
Smart Glasses	10%
People tracking device/ Pet tracking device	10%
Other	5%

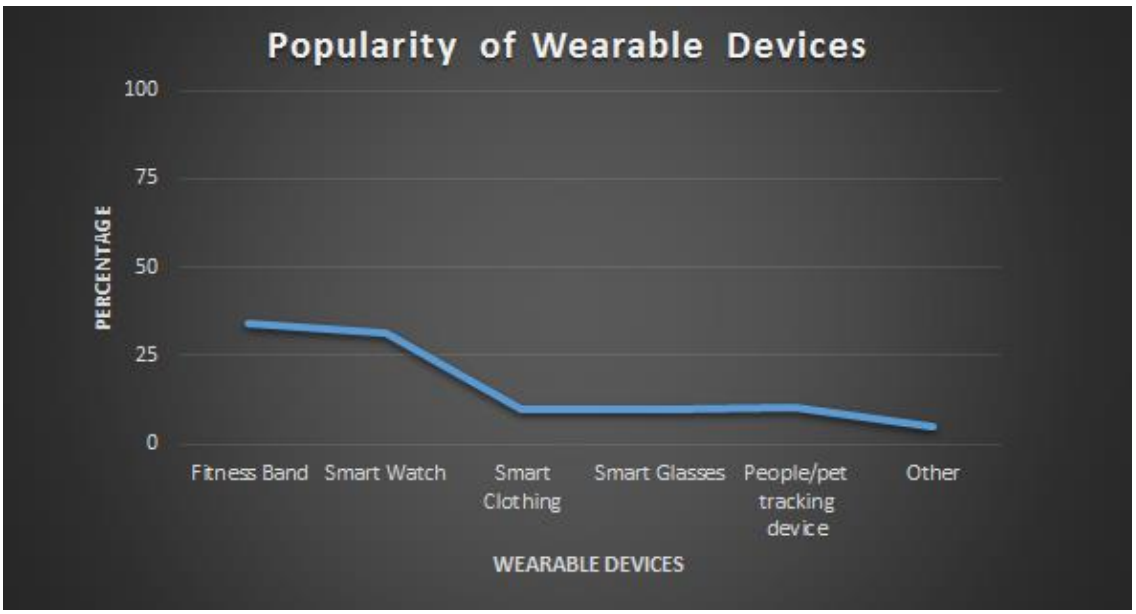


FIGURE 4. Popularity of Wearable Devices in Finland

The Figure 4 illustrates the popularity of wearable devices in major cities of Finland. Overall, it is indicating from Table 5 that the demand of fitness bands and watches are higher among other wearable devices, which is 34% and 31% respectively.

As it can be observed from the figures that fitness bands and smartwatches are quite popular in Finland. One of the possible reasons could be that these devices are used to fulfil various activities, such as maintaining health and fitness, entertainment, tracking and so on.

On the other hand, pet/people tracking devices are also commonly used among consumers. Because these devices are very useful in tracking. These devices have GPS connectivity, which allows individuals to track or determine the specific location.

However, pet tracking devices are used to track the movements of pets. These devices send notifications to their owner when their beloved pal is in danger. Further, when their pets are on the prowl then the device monitors all the activities and provides continues alerts to the owner. Further, the smart glasses and smart clothing are also essential wearable devices which are used to accomplish various purposes. Currently these devices have less demand in Finland, but maybe in the future, demand of these wearable devices may increase.

Although, 5 % have chosen the other option in which 2% have adopted heart monitor devices and rest of them are not using any kind of devices. The heart monitor accessories are those devices which are normally used by the elderly people for continues monitoring and recording the heart rhythm over a long period of time. These devices help them to determine the heart related problems.

Based on the facts given, we can say that fitness bands and smartwatches are the most preferable wearable devices among consumers, while others also have significant roles in various activities.

5.2 Usability of Wearable Devices in Everyday Life

Wearable technology is not so much popular in Finland but it is becoming more popular day by day. Therefore, to understand the usability of wearable devices in everyday life in Finland, below is the question which was asked from the local people in Finland.

How often do you use a wearable device?

a. Everyday
b. Occasionally

c. Never

TABLE 6. Adoption of Wearables in Daily Life

Time Period	Percentage
Everyday	15 %
Occasionally	36 %
Never	49 %

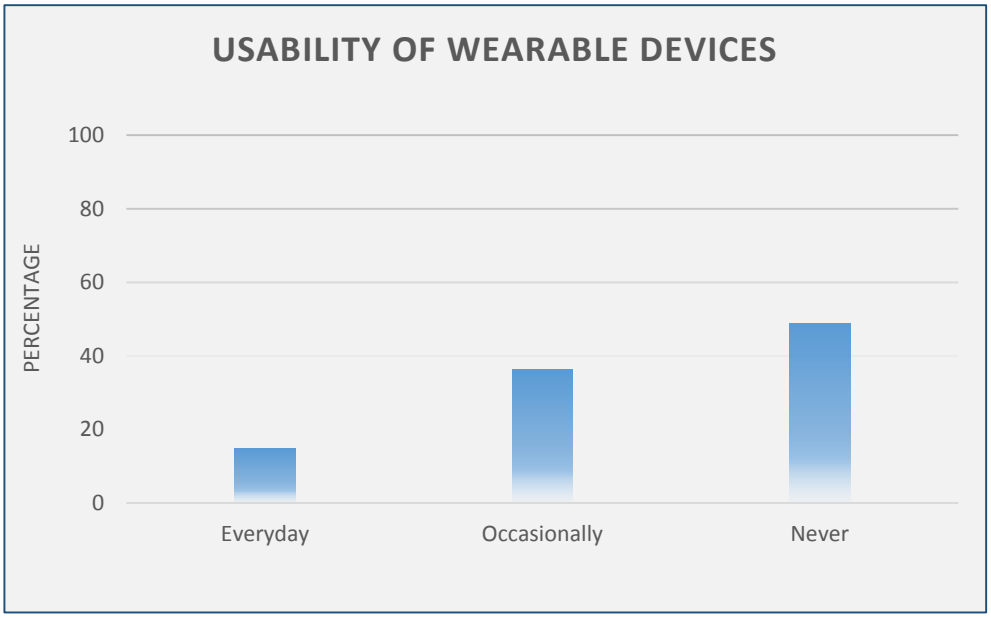


FIGURE 5. Usability of Wearable Devices

The bar chart in Figure 5 shows the usability of wearable devices in major cities of Finland. It is evident from the figure that around 49 % people are not using wearable devices at all, however 36 % are using these devices on an occasional basis. One of the possible reason could be that the wearable technology market is still in the developing stage in Finland.

Further, 15 % of the users have adopted wearable technology, which helps them to accomplish their daily activities as shown in Table 6. Individuals are using these devices continuously to monitor their health and fitness. However, wearable devices can be used for other purposes as well, such as for entertainment, sports, and in various other fields.

Over all, it can be concluded that 51 % of users have accepted wearable technology to change their life style and in the future these wearable devices may capture the technology market in Finland. The reason is that day by day it is getting popular and people are aware of the emerging technology.

5.3 Barriers to The Adoption of Wearable Technology

Wearable technology has great potential in it but it still has not become popular amongst the general public. The reason behind this is that there are several issues in wearable devices which is creating hurdles in the adoption of wearable technology. To identify the barriers in the adoption of wearable devices in Finland, below is the question which was asked from the general public.

According to your opinion, what are the barriers in adoption of wearable technology?

a. Limited functionality
b. Cost
c. Limited style
d. Lack of good applications
e. Less comfortable to wear
f. Too complex to understand
g. Other, Specify_____

TABLE 7. Current Barriers of Wearable Technology in Finland

Features	**Percentage**
Limited functionality	13 %
Cost	41 %
Limited style	10 %
Lack of good applications	12 %
Less comfortable to wear	12 %
Too complex to understand	7 %
Other	5 %

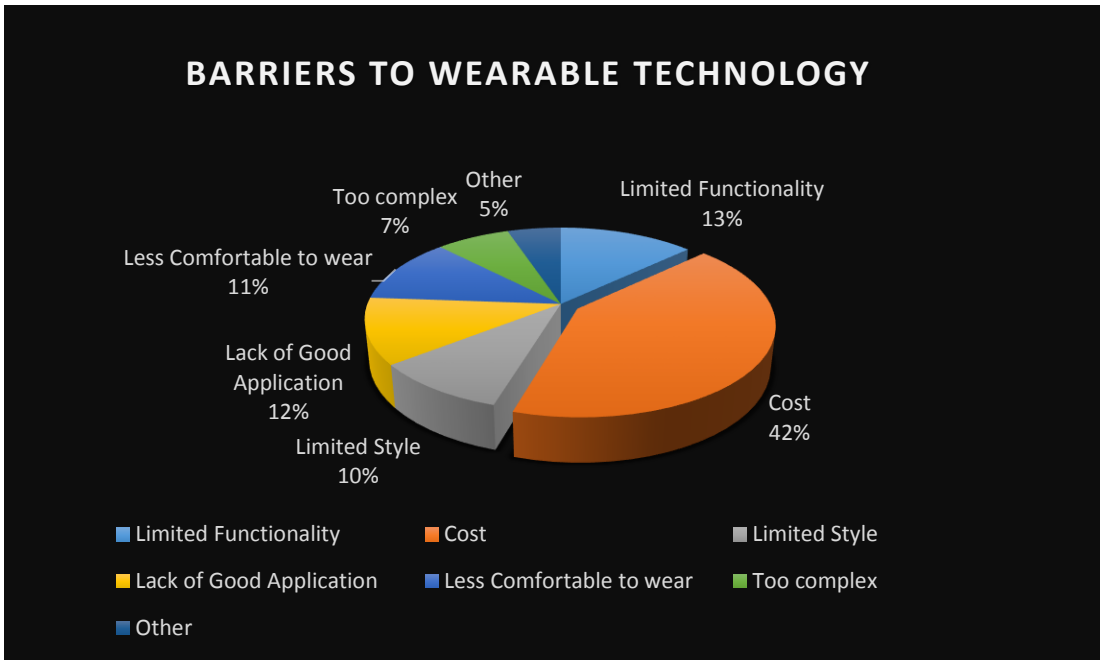


FIGURE 6. Barriers to Wearable Technology

The pie chart in Figure 6 shows that the barriers in adoption of wearable technology. Comprehensively, it can be seen that around 41 % users considered cost as a main factor which creates hurdles in embracing wearable technology. The main reason could be that the computing technology is still in the developing stage and manufacturing cost of these devices are high compared to consumer expectations.

However, limited functionality and lack of good applications are also creating problems for wearable technology to capture the technological market. Around 13% users decided that there is limited functionality available in wearable devices, while 12% consumers thought that there is lack of good applications in it which can be seen in Table 7.

On the other hand, many individuals have considered these devices as limited in style and not comfortable to wear, which is 10% and 11% respectively. As we know that consumer wants such types of devices which can easily worn in our body. If wearable devices are less comfortable to wear, than there are limited chances for the users to accept these devices.

Furthermore, consumers are frustrating with the emergence of wearable technology because the wearable is not easy to operate. Around 7% have though that wearables are too complex to understand and operate. The possible reason may be that there is less awareness of wearable computing devices in the

consumer market. 5% have expressed their views that there is no need of wearable technology in our daily lives.

Hence, the results show that there are various factors which may affect the popularity of wearables among consumers. Therefore, developers have to adopt such measure so that they can rectify such obstacles.

5.4 Impact of Wearable Technology On Society

Wearable technology has given a positive impact on society and the reason for this is that these computing devices makes technology more accessible and integrates it into everyday situations. Further, wearables will bring wide range of opportunities in future which helps consumer's lives in different ways. Below is the further explanation which shows that how wearables have impacted on society.

Do you think wearable technology has the positive impact on society? (In both cases, please specify the reason)

a. Agree
b. Disagree
c. Specify the reason_____

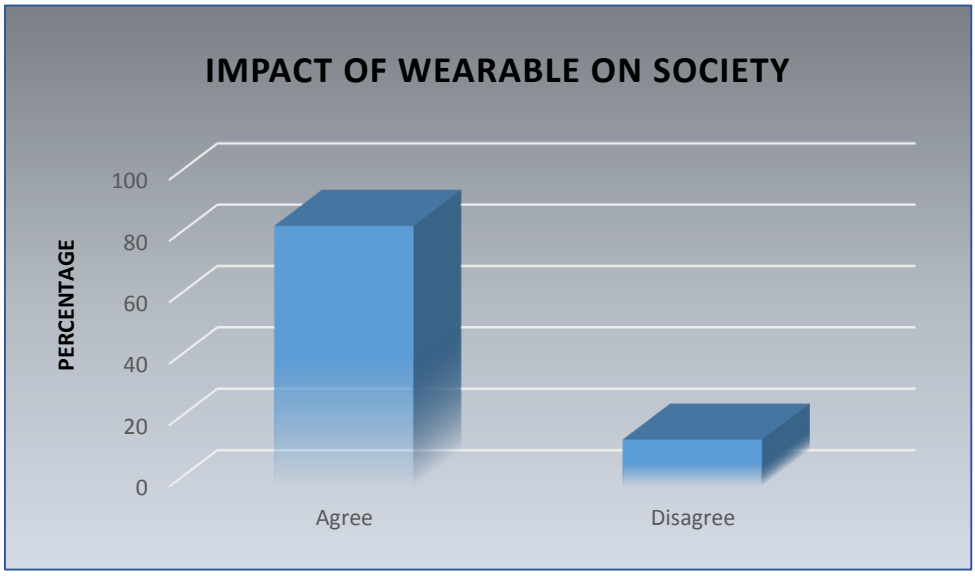


FIGURE 7. Impact of Wearable On Society

The above Figure 7 shows the impact of wearable technology on society. It is evident from the figure that around 85% people agreed that wearable technology has a positive impact on society. While 15% disagreed on the above statement.

Majority thought that wearable technology is essential for us because it makes our life easier. It has potential to show the real-time information to their users. They believe that with the help of wearable technology they will continue to monitor their health over a period of time. Further, it also encourages users to maintain their diet, sleep pattern and various physical activities. From wearable devices, every individual can collect data on a daily basis, rather than to go for physical exam.

However, on the other hand, people believe that individuals may be too attached with the technology which may create problems for the users in the future. While some said that we cannot rely on wearable technology because we don't have trust in it. There is privacy and security issues in it and our personal data is not save in these devices. Therefore, we can conclude that wearable devices play a significant role for making the user's life easier. But the above mentioned challenging factors are creating problems for wearables to meet consumers' expectations and therefore there is need to be find ways to overcome these issues.

5.5 Consumers Expectations from Wearable Devices

Adoption of wearable technology is rising day by day and users are expecting more from wearable devices than ever before. Therefore, designers and engineers are facing great challenges in meeting customer expectations. However, user's expectations towards wearable technology is explained below, which shows that what are the hopes of Finnish consumers from wearable technology.

What are the consumer/user expectations from wearable devices?

a. Good connectivity
b. Multi functionality/features
c. Maximum battery life time
d. Data security
e. Other, Specify

TABLE 8. Consumers Expectations of Finnish Users Regarding Wearables

Consumers Expectations	**Percentage**
Good connectivity	25 %
Multi functionality/features	28 %
Maximum battery life time	25 %
Data security	20 %
Other	2 %

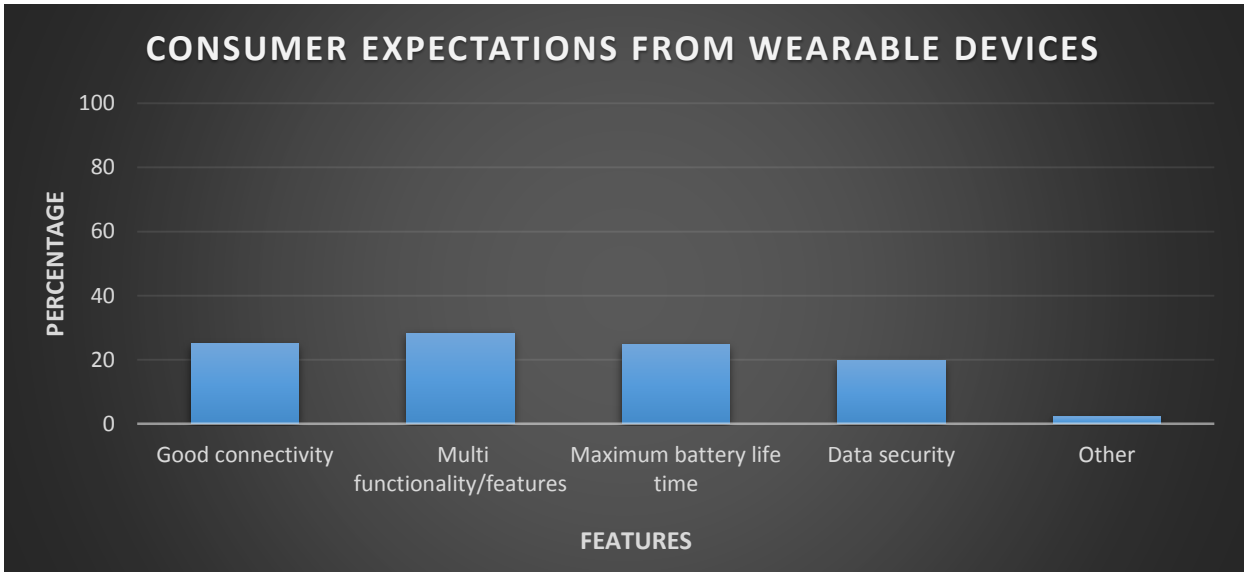


FIGURE 8. Consumer Expectations from Wearable Devices

Table 8 illustrates the percentage of consumer's expectations from wearable devices. It also shows that users are expecting worthy features from the wearable computing devices.

From Figure 8, multi functionality is the top most priority for the wearable devices, so that it can fulfil customer's expectations. 28 % users prefer that wearable devices should have multi functionalities. One of the possible reason could be that users want to do various task from wearable, so they don't wish to use multiple sensors which are hanging onto their arms. They need such type of devices which have all functions integrated into one single device.

However, 25% suggest that these computing devices should have good connectivity, so that users have possibility to connect with the real world all the time. While 24 % suppose that developer should work

on these devices, to increase the maximum battery life time. Minimal battery life is one of the critical problem in wearable devices.

Furthermore, data security is also one of the main problem in these computing devices. 20 % consumers expect that these devices must have good security system, because users may not face any inconvenience when they are storing their personal and crucial data in wearables. Subsequently, 2% believe that there must be update functions available. The reason behind this is that wearable devices are not easy to update because they are not frequently communicating with the internet. While others think that these devices should be reliable, so it can last for a long time.

In the end, it is clear that the above features should be adopted by the manufactures in order to sustain their demand of wearable devices in the market in Finland.

5.6 Most Useful Applications of Wearable Devices

Wearable technology has gotten much attention in recent years with the development of latest wearables devices. These tiny computers have the ability to record abundant amounts of data in them. Computing power of wearable devices have changed the way of users. Wearable technology has various applications in several fields, but the healthcare sector is the most potential sector for the wearable technology. Further, there are many sectors which has many benefits in Finland, but to find the most benefited sector, the questions below were asked from many Finnish peoples.

In your opinion, which industry would get more benefit from wearable devices?

a. Restaurant / food service
b. Health care / medicine
c. Industry / manufacturing
d. Entertainment
e. Military
f. Other Specify

TABLE 9. Most Benefited Industry from Wearable Technology in Finland

Applications of Wearable Technology	**Percentage**
Restaurant / food service	7 %
Health care / medicine	42 %
Industry / manufacturing	11 %
Entertainment	21 %
Military	18 %
Other	1 %

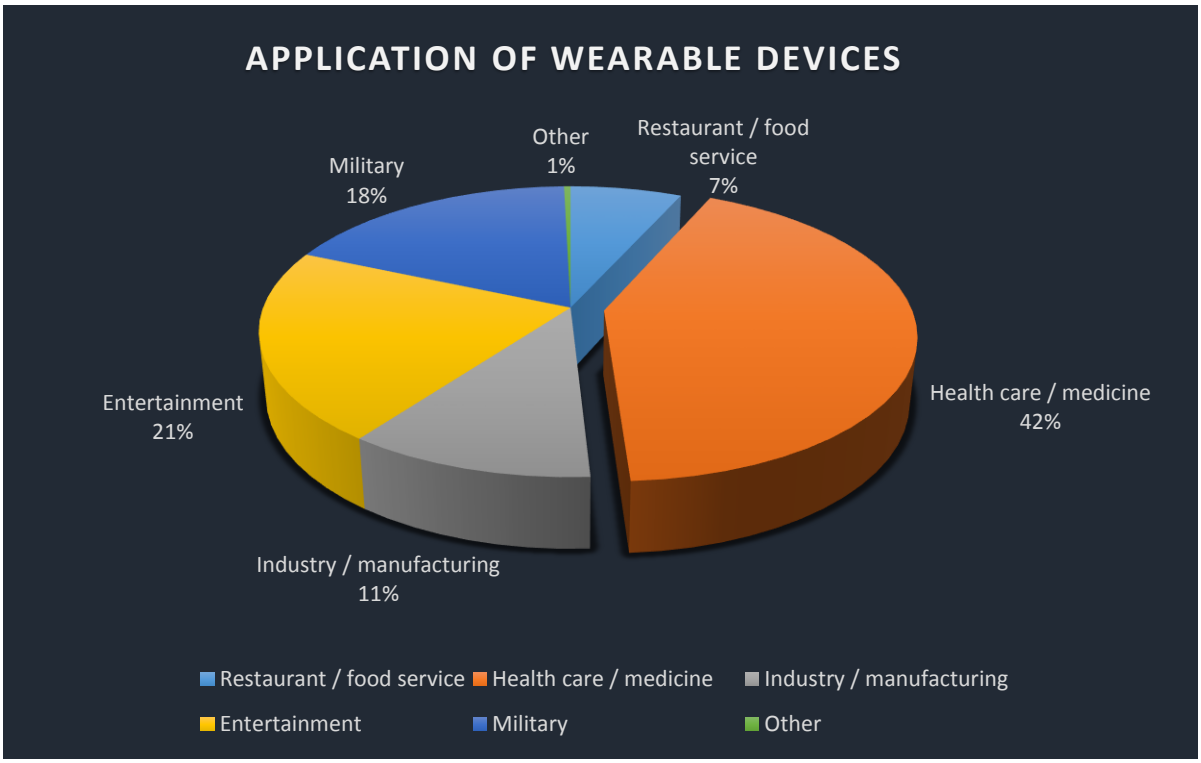


FIGURE 9. Application of Wearable Devices in Finland

The pie chart in Figure 9 shows the applications of wearable devices in various fields of the industry. Overall, it can be seen that health care / medicine sector was considered as most benefited sectors from wearable technology, which is approximately 42%. The reason being that wearable technology started to transform healthcare by assisting physicians in the operating rooms and providing health records in real-time. From these devices, users can track every single movement throughout the whole day which helps them to achieve their fitness goals.

Further, from the figure it is clear that wearable computing devices has also contributed their 21 % share in the entertainment industry. The entertainment industry has gained great success when they wearable devices were introduced, because these devices are giving such type of entertainment where users can experience virtual reality.

On the other hand, military and manufacturing industries have also embraced wearable technology. Around 18% and 11% share of wearable has contributed by the military and manufacturing industries which can be shown in Table 9. Reason of introducing these wearables are that these devices may improve their productivity and efficiency in their respective sectors.

The restaurant / food service industry was also helped by wearable technology. Around 7% of wearables are used in that sector. As these types of technology have changed the method for delivering and ordering of fast food in the food service industry. 1% of wearable devices was also popularized in the other industries.

In the end, it can be concluded from the above figures that wearable technology has played a vital role in all the sectors but it has contributed and introduced various portable devices in the health care/ medicine industry.

5.7 User Challenges in Wearable Technology

Wearable technology is always offering new capabilities to users in their daily lives but wearable gadgets are suffering from development challenges. Users face various challenges while using wearables. Below is the explanation which shows the major issues which is faced by the users while using wearable devices.

What major issues do you face while using wearable devices?

a. Privacy and Security
b. Battery issues
c. Interface / display
d. Less compatible with other devices
e. Other, Specify

TABLE 10. Major Challenges Facing by Users in Wearables

Major Issues	**Percentage**
Privacy and Security	28 %
Battery issues	36 %
Interface / display	12 %
Less compatible with other devices	20 %
Other	4 %

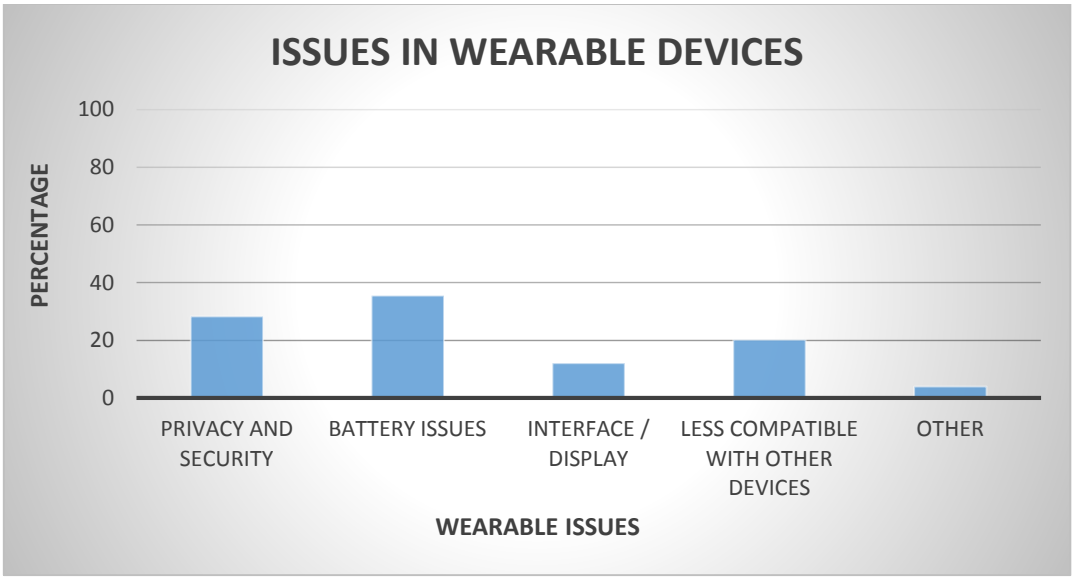


FIGURE 10. Issues in Wearable Devices

The above Figure 13 explains the major issues in wearable devices. Around 36% of the consumers in Finland have experienced battery issue as one of the main problems. One of the key reason could be that these devices are small in size and to solve battery issues developer have to apply other tactics. They cannot increase the size of wearables because they might lose popularity. Users will prefer to use wearables as long as these devices are small and easy to wear.

Additionally, privacy and security always used to be a major challenge in wearable devices. From the research it shows that wearable devices are not fully secure. 28 % have decided that these electronics are not trustable which can be shown in the Table 13. The main cause is that these computing devices have a small processor therefore it is hard to apply traditional data security measure in it.

Further, 20 % of the individual stated that wearables are less compatible with the other devices, because it may have less features and functionalities as compare to other electronic devices, such as smart phones, tablets etc. However, interface / display is also important for the electronic devices. In the case of wearable display size is small, which may create issues for users to adopt it. 12% believed that display / interface dimensions are not enough. Because it may be hard for the users to read a text from such a small display. While in other options, 4% of the consumers experienced that these electronic devices have other issues as well, such as less durability, lack of good applications and heating issues. Therefore, it can be determined from the results that less battery life and security and privacy are the major issues in the wearable devices.

5.8 Usage of Wearable Technology at The Workplace

Wearable technology plays a significant role in the workplaces. It makes users more effective and productive at work. In the future wearables will used everywhere at work just like smartphones can be seen everywhere now. To know when wearable technology will be used as a work place tool in Finland, the following research was conducted as seen below.

When do you think that wearable technology will be used as a work place tool in Finland?

a. In the next 2 years
b. In the next 3 years
c. In the next 5 years
d. In the next 10 years
e. Will not be used at work place

TABLE 11. Future Possibility of Wearable Devices Used in Work Place

Years	**Percentage**
In the next 2 years	16 %
In the next 3 years	16 %
In the next 5 years	44 %
In the next 10 years	23 %
Will not be used at work place	1 %

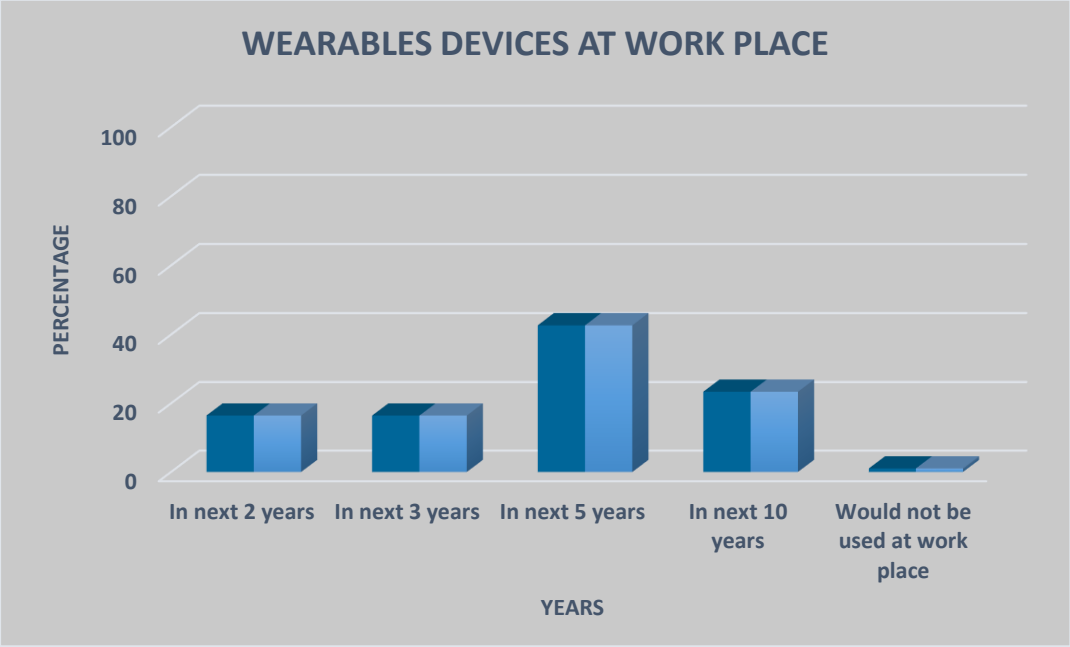


FIGURE 11. Wearable Devices at Work Place

Figure 10 shows the forecast of wearable technology at the work place. It is evident from the figure that in the next five years, wearable devices will be used at work place, according to the consumer viewpoint in Finland, which is 44 % respectively. The reason behind is that wearables gadgets are not so much popular in Finland these days, as it is still in the developing stage. But in the future, when it reaches the peak, then it may be used at work places.

Moreover, some individuals though that these electronic devices may be introduced at work place in the next 2 to 3 years. One of the possible reason could be that there may be great innovations of wearables in the technological world, so it may be led to various work sites.

However, 23 % believe that there are still enough years to consider wearable at various fields. It may happen when there will be a large decline of wearable computing market in the next couple of years. 1% contemplated that these devices will never be used at work place can be seen in Table 10.

Hence, it can be concluded that users have high expectation to adopt wearable as work place tools in Finland in the next couple of years. However, consumer expectations are totally depending upon the future market of wearable in the technological world.

5.9 Popular Wearable Companies in Finland

Wearable technology is one of the most exciting technological trends nowadays. It has grown over the years and got great success in every field by improving user's daily lives. There are various technology companies which are already moving into the wearable segment but few are preforming much better than others. Below are some companies that got great popularity nowadays in Finland.

Which wearable technological company do you think is the most popular nowadays in Finland?

a. Apple
b. Samsung
c. Fitbit
d. Google
e. Huawei
f. Sony
g. Other, Specify

TABLE 12. Popular Wearables Companies in Finland

Applications of Wearable Technology	**Percentage**
Restaurant / food service	7 %
Health care / medicine	42%
Industry / manufacturing	11%
Entertainment	21%
Military	18%
Other	1%

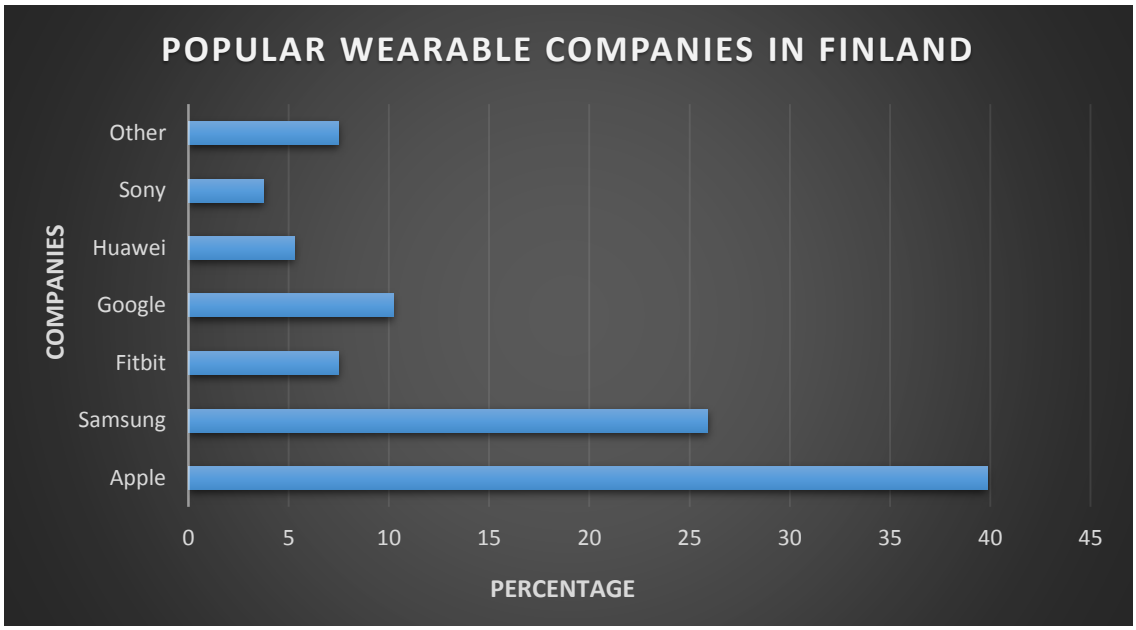


FIGURE 12. Popular Wearable Companies in Finland

Figure 11 illustrates the information which is related to the popular wearable companies in Finland. It can be seen from the figure that people prefer Apple devices to fulfil their daily activities. Apple gadgets got high popularity among Finnish people, which is 40% respectively. Reason of popularity will be that Apple is one of the famous brand in the technology world.

The next most popular band in wearable technology in Finland is Samsung. 26 % of the consumers have adopted Samsung devices to accomplish various task as shown in Table 11. Possible reason could be that Samsung smartwatches are promoted as one of the favoured watches in the world. However, 10 % of the consumers want Google electronic devices in various activities, which is evident that Google devices are also attractive in Finland.

On the other hand, Fitbit and Huawei companies are also popular among Finnish consumers. 7 % and 5 % users are attracted to these companies. These brands are demanded among users because Fitbit has developed various fitness bands which have got great success in the wearable market, while Huawei's smartwatches are also successful in the consumer market as well. Further, 4 % individuals have also agreed to use wearable devices of Sony.

Additionally, In the other option, 8 % of the consumers prefer wearable computing devices from Polar and Suunto companies, while the rest of them don't know that which companies are the most popular in Finland. Polar and Suunto are Finnish companies and they are also popular in other countries as well.

In the end, it is clear that various companies are highly popular in Finland, but wearable devices of the Apple company are the most favourable among consumers.

5.10 Benefit of Wearable Technology for Target Groups

Different target groups have received potential benefits from wearable technology. They are doing various daily activities with the help of wearable devices. To know which class of people are more reliable and more comfortable in using wearable technology, I have asked following question.

In your opinion, which target audience would be more beneficial from wearable technology?

a. Kids
b. Adults
c. Old age
d. Animals

TABLE 13. Target Audience to Get More Benefit from Wearables

Target Audience	**Percentage**
Kids	16 %
Adults	51 %
Old age	25 %
Animals	8 %

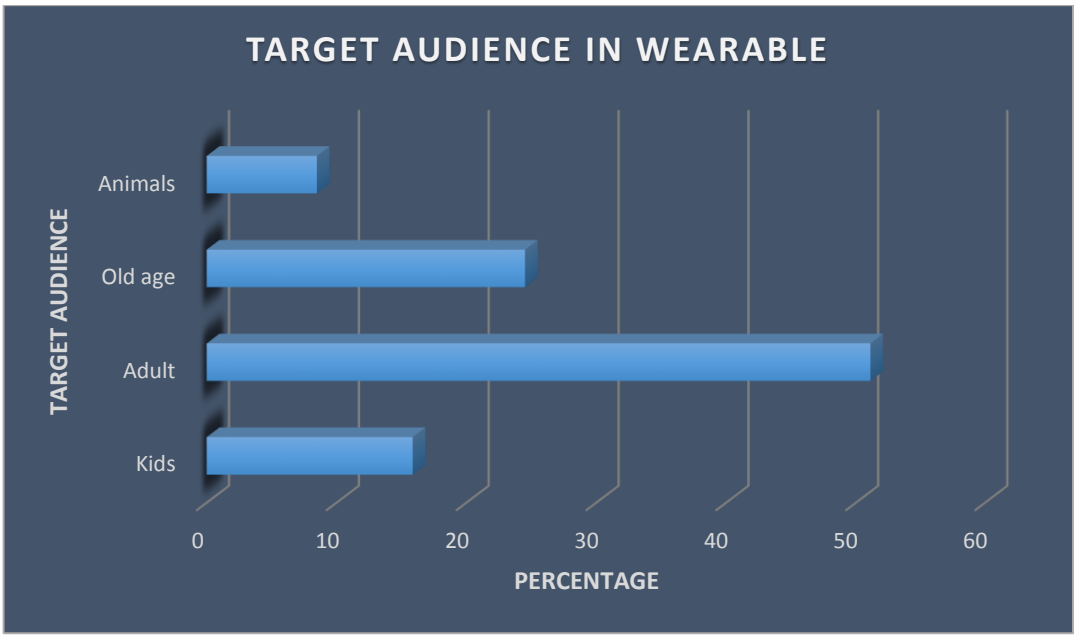


FIGURE 13. Target Audience in Wearable

Figure 12 has explained which target audience would gain the most benefits from wearable technology. It can be seen from the figure that 51 % adults would benefit from wearables. The key reason is that adults are more health conscious these days, and they are willing to use wearable devices to monitor their health and fitness level throughout the day. They have also adopted that technology to accomplish various needs.

Further, 25 % old age consumer group, is the second largest target audience which has benefited from wearable devices. A great number of adults have accepted wearable technology is because it is useful and hasn't created any disturbance in their normal life.

Moreover, these electronic devices have also been advantageous for kids as well. 16 %, of the kids group, have embraced these devices, to fulfil daily routine tasks as shown in Table 12. They are using these devices for various purposes, such as education, entertainment, health and so on. Further, these devices are normally designed for the safety of the kids. For example, parents may track the location when they are outside, sleeping pattern and other activates as well. Besides, 8 % of the users though that these electronic devices are also valuable for animals too. These gadgets are used to monitor the health of our pets and as trackers through GPS when they are on scavenge/hunting trips. Therefore, wearable technology is advantageous for four target audience, which are mentioned as above.

5.11 Popularity of Wearables in Different Age Groups

Wearable popularity is varying, according to the different age groups, because different age groups have different attitude towards wearable technology. Wearable devices are most popular among youngsters compared to other age groups

TABLE 14. Popularity of Wearable in Different Class of People

Age groups	Percentage
Group 1: Youngsters	51 %
Group 2: Employed	48 %
Group 3: Old Age	1 %

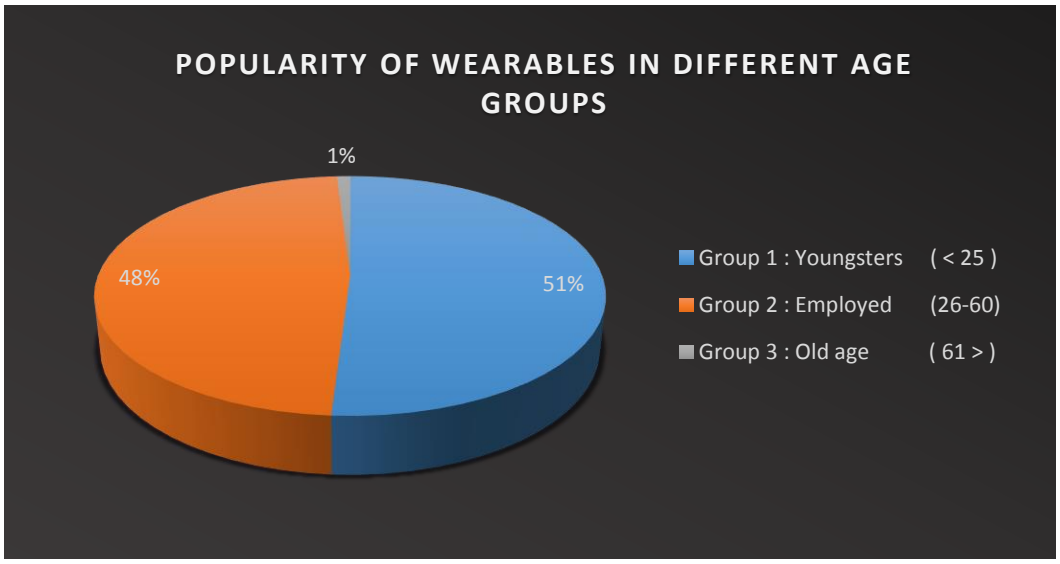


FIGURE 14. Popularity of Wearable in Different Age Groups

The given data presented in Table 14 shows the information about the popularity of wearables in different age groups in Finland. As it can be seen in Figure 14, which is that youngsters used wearable technology more than other age group. Around 51 % youngsters have embraced wearable devices, which is a higher percentage compared to the old age group. The main reason could be that youngsters are more aware of latest technology.

According to the data given, about 1 % old people are using these computing devices, reason being that mostly elderly people live alone and they are less attached with current edge technology compared to youngsters and employed person. This is the reasoning that these people are less familiar with the wearable devices.

However, employed person from the 26-60 years old are also attached with the wearable devices these days. Approximately 48 % are engaged with these computing devices while slightly less percentage than used by others. Most of the middle-aged people have adopted wearable technology because they are enthusiastic about their health and fitness, and they believe that it is a prefect option to monitor their daily health activities with accuracy.

As observed from the pie chart, wearable technology is popular among youngsters. And in the future, we will see that demand of these computing device will increase among these groups.

5.12 Usability of Wearables Based On Gender

There is always a contending view on the usability of wearable technology based on men and women. But it is essential to analyse the major consumers, so that companies can improve their products which can satisfying consumer demand.

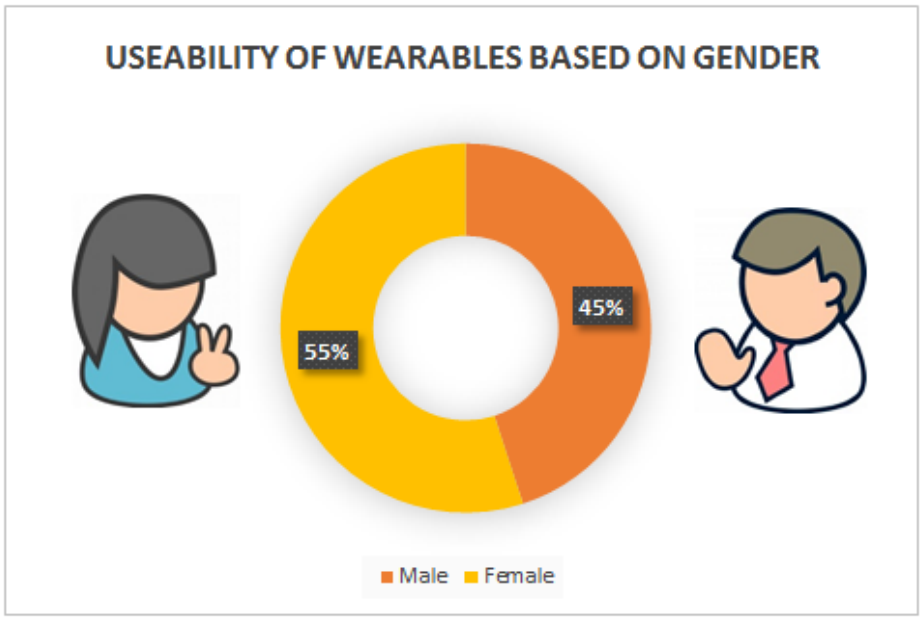


FIGURE 15. Usability of Wearables Based On Gender

The above Figure 15 provides information on the usability of wearable devices based on gender in Finland. From the figure, it is clear that 55 % females have adopted wearable technology which is a higher percentage compared to men. The high percentage shows that wearable market is dominated by females, the reason could be that they are more health conscious than males.

However, 45 % males have embraced wearable technology which is slightly less than the usability of females. Males have accepted to use wearable devices in their daily activities because these gadgets may help them to stay connected with the real world.

Further, wearable technology is popular among both genders. They both use wearable devices for various purposes, such as for entertainment, information, sport, social network, getting 24/7 health and so on.

Therefore, it can be concluded that wearable technology is popular among both genders, but more usability is with females. As they may want more features, mostly stylish ones.

6 CONCLUSION

Wearable technology is the incorporation of technology with regular accessories which allow users to make their life easier. It has changed the lifestyle of users in order to achieve their particular goals. This technology has immense potential for rapid growth and can provide benefits to the different classes of people in their daily lives.

Many sectors have received huge benefits from wearable technology, but the health care sector was considered as one of the most benefited application area. The reason being that wearable technology started to transform healthcare by assisting physicians in the operating rooms and provides health records in the real time. From these devices, users can track every single movement throughout the whole day which helps them to achieve their fitness goals. Further, the healthcare industry as a key market for the early success of wearable technology and in future, there will be a significant demand for the wearable monitoring system in the healthcare sector.

Furthermore, there are various wearable devices already available in the market but the most popular devices are the fitness trackers and smart watches. These wearables are beneficial and suitable gadgets to measure physical attributes of people. These devices have gotten huge popularity all the over world and consumers are using these devices to fulfil their various activities throughout the day. Mainly these devices are used to monitor health and fitness of users. But consumers are also using wearables to remain connected with social network, entertainment and stylish purposes as well.

It can be seen that wearable technology has a great amount of potential in it and consumers have also embraced wearables in their daily lives, but still, they are facing some challenges in these devices. One of the main concern of users is the privacy risk and potential security of these computing devices. They believe that wearable technology will bring a wide range of opportunities in the future which helps individual's lives in various ways. But without solving security and privacy issues from wearables, it may effect on frequent use of wearable technology.

On the other hand, this thesis has also explained the overall market trend of wearable technology around the globe, which has shown that wearable technology is popular among consumers. Also, from the research it can be seen that among all the wearables fitness tracker from Fitbit is the most favourable by

users. While in Smart watches, Apple and Samsung companies have got tremendous success in the consumer electronic market.

In my thesis, I have also done a research study which is related to the consumer perspective of wearable devices in Finland. Basically I have conducted a survey which shows different aspects of wearables and explained that which wearable technology is the most popular among Finnish people. From the results of the survey, I found that Fitness bands are the first priority, while smart watches are in second position. The main reason could be that Finnish people are more health conscious therefore they have chosen fitness bands to track their health and fitness activities. From the research, I found that around 15 % are using wearable devices on regular basic while 36 % have adopted these devices occasionally. As we know that the wearable market is still in the emerging phase in Finland, this may then be the reason that the adoption rate of wearables among Finnish people is relatively low. But in the future, we will see that wearable devices will take off in Finnish consumer market within couple of years. Further, according to the survey report, cost is the main barrier in adoption of wearable technology. One of the possible reason may be that technology is still growing and the demand of these devices is high but the supply is less, therefore the overall price of these devices is high in market. Furthermore, many believe that wearable technology gave a positive impact on society, because these computing devices makes technology more accessible and integrates it into everyday situations.

On the other hand, Finnish users believe that wearable technology is a prefect option to monitor our daily activities easily, but still it is not considered as a fully secure device. Major issues they have faced while using wearable devices are the low battery power/charging issues along with privacy and security.

The most popular wearable company nowadays in Finland is Apple. Because it is a well-known brand all over the world, the products of Apple Company always have multi-features and they are reliable. Additionally, wearable is popular among youngsters and employed persons, and these groups have adopted wearable technology in accomplishing their various activities.

However, around 55 % females have embraced wearable devices in Finland, which is higher percentage compared to males. The reason being that females have always huge concern to maintain their health and fitness, also they want to remain connect with the real world.

Moreover, this thesis is also beneficial for wearable companies who want to invest in Finland. The thesis can provide information that which age group they should target in order to achieve success in the Finnish market. Further, they can also get the idea of which particular devices is popular among youngster. Generally, companies will understand the overall attitude of consumers towards wearable technology. From this work, companies can predict future market trend related to wearable devices in Finland.

Thus, the thesis gives the general idea of wearable technology and its applications in everyday life. It also elaborates technical issues and social aspects of wearable devices. Further, the thesis also explains the statistics which show the general trend of the wearable market around the globe. Moreover, from the survey study, it can be analysed that future wearables market will grow in Finnish consumer market.

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APPENDIX 1

Survey on Wearable Technology for Finland

Age :_____
Gender :_____
Field of Study/ Profession :_____
City :_____

1. Which wearable are you currently using/ willing to use?
   a) Fitness Band ( )
   b) Smart Watch ( )
   c) Smart Clothing ( )
   d) Smart Glasses ( )
   e) People tracking device/ Pet tracking device ( )
   f) Other, Specify_____

2. How often do you use wearable device?
   a) Everyday ( )
   b) Occasionally ( )
   c) Never ( )

3. According to your opinion, what are the barriers in adoption of wearable technology?
   a) Limited functionality ( )
   b) Cost ( )
   c) Limited style ( )
   d) Lack of good applications ( )
   e) Less comfortable to wear ( )
   f) Too complex to understand ( )
   g) Other, Specify_____

4. Do you think wearable technology has the positive impact on society? (In both cases, please specify the reason)
   a) Agree ( )
   b) Disagree ( )
   c) Specify the reason_____

5. What are the consumer/user expectations from wearable devices?
   a) Good connectivity ( )
   b) Multi functionality/features ( )
   c) Maximum battery life time ( )
   d) Data security ( )

e) Other, Specify_____

6. In your opinion, which industry would get more benefit from wearable devices?
   a) Restaurant / food service ( )
   b) Health care / medicine ( )
   c) Industry / manufacturing ( )
   d) Entertainment ( )
   e) Military ( )
   f) Other, Specify_____

7. When do you think that wearable technology will be used as a work place tool in Finland?
   a. In the next 2 years ( )
   b. In the next 3 years ( )
   c. In the next 5 years ( )
   d. In the next 10 years ( )
   e. Will not be used at work place ( )

8. Which wearable technological company do you think the most popular nowadays in Finland?
   a) Apple ( )
   b) Samsung ( )
   c) Fitbit ( )
   d) Google ( )
   e) Huawei ( )
   f) Sony ( )
   g) Other, Specify

9. In your opinion, which target audience would be most beneficial from wearable technology?
   a) Kids ( )
   b) Adults ( )
   c) Old age ( )
   d) Animals

10. What major issues do you face while using wearable devices?
    a) Privacy and Security ( )
    b) Battery issues ( )
    c) Interface / display ( )
    d) Less compatible with other devices ( )
    e) Other, Specify_____