Disruptions caused in Pakistan by the COVID-19 Pandemic and their Wireless Technology Based Solutions

Ayesha Rafique
Sir Syed University of Engineering & Technology

Noreen Akram
Sir Syed University of Engineering & Technology

Umar Syed Muhammad Talha (stalha@ssuet.edu.pk)
Sir Syed University of Engineering & Technology https://orcid.org/0000-0001-5452-5329

Muhammad Umar Khan
Sir Syed University of Engineering & Technology

Razia Zia
Sir Syed University of Engineering & Technology

Muhammad Aamir
Sir Syed University of Engineering & Technology Faculty of Engineering

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Abstract

Since its emergence in 2019, the novel coronavirus or COVID-19 pandemic has caused severe disruptions in every field of life. The world has turned its focus toward digital technologies to fight against the socio-economic disruptions caused by the pandemic. The associated digital technology based solutions predominantly rely on the advancements in wireless and communication technologies. These wireless technologies help in fighting the global crisis in various ways, including virus-spread monitoring, maximizing healthcare outreach, mitigating the physical barriers through automated visual inspection systems and online video conferencing solutions, and enabling distance and virtual education. However, the problem further intensifies in developing and underdeveloped countries, due to the lack of facilities, increased poverty ratio, and poor socio-economic situation. This paper reports various wireless technological solutions for the COVID-19 pandemic as experienced by one such developing country, Pakistan. The paper highlights the use of wireless technologies in various fields for fighting the COVID-19 pandemic, such as e-commerce, education, and the healthcare sector.

1 Introduction

Coronavirus disease 2019 (COVID-19) is a global pandemic that has been declared by World Health Organization. This virus outbreak caused a global health emergency across the world which erupted lungs and respiratory sickness cases. The first case was initially reported to the (WHO) in December 2019, in Wuhan City of China. Afterwards, WHO declared the COVID-19 a global pandemic.

COVID-19 is persistently disrupting the world even after almost 2 years since the first case was reported. This infectious disease hit the world in late 2019 and its destructions are continued in 2022. The COVID-19 epidemic has changed the way of living drastically. World leaders and governments' tactics and strategies failed to address this global issue; with the majority opting for the closing of borders and implementing lockdowns. These lockdowns affected every walk of life. From business tycoons to small business operators, all faced terrible degradation in their economic regime. This pandemic situation transformed the lives least progressive ones. Unsurprisingly, the pandemic has triggered a wave of mental health issues. Human behavior also changed due to this fearful situation. Every individual probably had the worst psychological effect of this century as everyone is so fearful to meet and greet their beloved. The pandemic affected every field including the education sector, HealthCare sector, Economic sector and various other sectors. In order to combat this situation, the world has implemented various solutions, where Digital technologies have been in limelight to fight the global crisis. Wireless technologies provide alternative solutions to combat this pandemic by supporting healthcare automation and facilitating virtual education and conferencing. E-Commerce has gained extensive popularity in the last few years. Even when the pandemic is declining, people are still cautious, and many will still prefer shopping online from the vicinity of their homes.

Countries from underdeveloped nations to technologically advanced countries, all are affected by the COVID-19 disruptions. However, the problem further intensifies in developing and underdeveloped

countries, due to the lack of facilities, increased poverty ratio, and poor socio-economic situation. This paper reports various wireless technological solutions for the COVID-19 pandemic as experienced by one such developing country, Pakistan. The paper highlights the use of wireless technologies to mitigate the disruptions caused by the COVID-19 pandemic. Wireless solutions used in various fields have been reported, such as e-commerce, education, and healthcare sector.

The following section describes the COVID-19 disruptions caused in the education sector and their associated wireless solutions. This is followed by healthcare and economics sector based disruptions and associated solutions; and finally, the conclusion is presented.

2 Education Sector

COVID-19 changed every walk of life including education. Schools, Colleges, and Universities have been closed for months throughout the world, and as social distancing policies continued [1]. The education sector is one of the few important sectors that need to be continued even in the lockdowns, otherwise, the disruption due to discontinued education can be very devastating. Academic progress, college admissions, and employment chances can all be negatively affected by educational failures. Over 91% of the world's student population is affected by these countrywide closures [2]. Just like every other country in the world, COVID-19 also struck Pakistan with its devastating impact. Education in all the cities of Pakistan was also discontinued due to this infectious disease.

Currently, online education is the only possible solution to continue a learner's education. In technologically evolved nations, e-learning may be productive [3], however, less digitally developed and digitally literate nations face problems. A decent internet connection and access to a digital device are required for e-learning; however, not all learners and instructors in Pakistan have digital devices or high-speed internet connections, which hurdles the transfer of information in an online learning environment. To cope with the difficult situation, the educationalist adopted two online modes for education namely Synchronous Online Education Mode and Asynchronous Online Education Mode [4]. There is another mode of education that has been adopted by Pakistan to minimize the deterioration made by COVID-19 is Hybrid Education Mode.

2.1 Synchronous Online Education Mode (SOEM)

In the Synchronous Online Education Mode (SOEM), all the learners get their online learning through a prescheduled lecture. Every learner needs to connect their digital devices through the internet and the instructor is also bound to be there for the pre-schedule lecture. All the communication between the learner and the instructor occurs in real time. This mode of online learning is considered more effective and engaging as the learners have the liberty to generate queries during the online lecture by using live chat and instant voice messaging. However, as this mode of online learning is time bound, it is always difficult to manage and deliver.

2.2 Online Platforms to support SOEM

2.2.1 Virtual Classroom

Pre-COVID-19 education is somewhat different from the online or virtual learning environment. The instruction and learner were there in the classroom physically to interact with each other and can maximize their learning. However, post-COVID-19 is a bit different where the instruction and the learner may need to use a common virtual classroom to communicate with each other. Learners may learn and engage with Instructors and other students from all around the world by using these virtual classrooms [5].

Microsoft provides a self-developed business communication platform as a part of the Microsoft 365 suite. It offers workspace instant chat and video conferencing facilities along with file storage capability and application integration. This wireless application is used by various Universities because it is extremely user-friendly and helps in creating a collaborative learning environment amongst learners and instructors residing in remote areas. Apart from the video conferencing feature, this application provides an international dialing facility, lecture recordings, saving chats, and administrative controls.

Google Classroom is a free-of-cost, blended learning environment for scholastics that promises to make creating, sharing, and grading lessons easier. Primarily, Google Classroom facilitates the instructors and the learners to access the learning material more efficiently. This web-based platform provides G-suite services including Google Docs, Google Calendar and Gmail to ease communication and organize the learning environment among all learners.

Blackboard is a Learning Management System (LMS). This application provides the learners a single platform to browse course announcements and contents, grade tasks, submit assignments, linkage among other learners to perform group discussions. From a learner and instructor perspective, it is a user-friendly application. The application is compatible with both iOS and Android smartphones.

2.2.2 Video Conferencing

Video Conferencing is another way of communication in an online learning environment. It is an internet tool that enables participants in various places to have face-to-face meetings without having to travel to the same spot.

Google Meet is another wireless application that is widely used by learners all around the world. This video conferencing wireless application is owned by GOOGLE. Any learner or instructor having a google account is eligible to create an online video conference of up to 100 members and the video conference can run for an hour per conference. Like Microsoft Teams, this application is also capable of providing administrative rights, meeting recordings, and an international dialing facility.

Like Google Meet, ZOOM is also a USA based video conference application that is commonly used by Schools and Universities during this pandemic. It uses a cloud-based peer-to-peer application platform to deliver video conferencing and online chatting facilities. After quarantine measures were implemented in response to the COVID-19 pandemic in early 2020, Zoom's software usage witnessed a significant global

surge. Its software products have been scrutinized by the public and the media for security and privacy concerns.

Skype is also a very handy online video conferencing platform. It allows users to contact other Skype users for free via instant messaging, audio, video, and screen sharing, as well as up to 100-learners conference calls. Although Skype may be used for business rather than schooling purposes, it is better suited for personal usage or small businesses.

2.2.2 Erasmus + CENTRAL Project

One particular example of technological advancement in Education Sector is the Erasmus + funded project named CENTRAL, which is **C**apacity building and **E**xcha**N**ge towards attaining **T**echnological **R**esearch and modernizing **A**cademic **L**earning. It is a consortium of 09 international universities comprises of 06 Asian and 03 European universities. The CENTRAL project seeks to strengthen and integrate academic educational curricula with an international orientation in content and/or form, to empower learners to make (professionally/socially) in a globalized perspective and constructed for domestic and/or foreign (international) students CENTRAL aims to improve the employment, globalization, and multidisciplinary involvement of students, graduates, and research employees.

With the same intent, the CENTRAL project provided knowledgeable opportunities to all the universities of its consortium. To combat COVID-19 situation and sustain the education system without disruption, the CENTRAL project managed to deliver a series of online training sessions on creating and managing a Virtual Learning Environment. Many universities which were unprepared for the pandemic situation and unable to provide quality education during this disastrous period, learned the most from these training sessions. Sir Syed University of Engineering and Technology (SSUET), one of the most prominent engineering universities in Pakistan and a member of the CENTRAL consortium, devised a way to continue education among learners and practically deployed a Virtual Learning Environment (VLE). The VLE platform benefited 1200 + students of Sir Syed University of Engineering and Technology. The VLE portal made all the learning material readily available on a single portal which helped students. VLE portal also made online assessments easier. The flexibility, ease of use and agility of VLE portal made the education system runs smoothly during the stressful period of the pandemic. A pictorial representation of the developed and deployed VLE as adopted by SSUET is shown below in Fig. 2.

2.3 Asynchronous Online Education Mode

In the Asynchronous Online Education Mode (AOEM), students have the flexibility to get the learning at any time as this online mode of learning is not time bound. This mode of online learning offers confidence to the learners to improve their learning at their own pace. The learner interacts with the course management system, communicating using emails, discussion forums, blogs, and reading articles. However, as this mode of online learning does not support live lecturing and video conferencing, students may face difficulty in instant communication with the instructor.

2.3.1 Recorded Lectures

Asynchronous learning is enabled by pre-recorded lectures; the learners may study when they are best able to learn and take breaks when necessary. Students, on the other hand, may miss the excitement that comes from a live conversation and being present in person.

A podcast is a Personal On Demand broadCAST, digital audio or video recording which are available on cyberspace to get downloaded on learner's digital devices. These digital recordings are generally available in a series. Each learner can subscribe and learn from the audio/video pre-recorded content.

YouTube is a popular USA based video sharing platform owned by Google. Many YouTubers create YouTube channels free of cost to facilitate education. They upload video lecture series related to various educational topics on YouTube. This platform is popular among students as they can generate queries by writing questions in the comments window. This comment space is open to all users which helps in providing answers lesser time.

Power Points comes with Microsoft Office Suites. It is very handy and can easily be used by instructors to record lecture videos. Some features can be utilized to maximize the learning for the students such are pen features to annotate and highlight important points in a PPT. The video recordings can be saved on the PCs and uploaded on any cloud-based service to share among students.

2.4 Hybrid Education Mode

The Hybrid Education Mode is a combination of online and physical ways of learning. Some HEIs preferred this mode of teaching as it offers a combination of online as well as on-campus activities by maintaining social distancing policies. In this education mode, each learning class splits into two groups of learners. The first group of learners is allowed to sit in the classroom and meanwhile the second group of learners can connect through any of the online learning platforms suggested by the instructor.

The hybrid modes provide many benefits such as the school can adopt a social distancing policy implemented by the government. The school can offer a seating plan for the first group of learners, in which students are allowed to sit in a classroom by maintaining distance from fellow students. The physically present students can participate in classroom activities. Likewise, a school can offer a separate seating plan to the second group of learners where students of the second group can participate in class activities while the students of the first group of learners can be connected online.

2.5 Issues faced in Online Education in Pakistan and their Solutions

The above mentioned three modes of online learning have some problems which are related to resource constraints. The possible solutions are also mentioned to overcome the effect of various issues related to online learning.

2.5.1 Electricity/ Power outages

Online education greatly depends on the availability of electricity. Many parts of underdeveloped countries including Pakistan are still facing problems in providing electricity to their citizens. Unavailability and power failures are the primary hurdles faced by many learners in the continuation of their education during Pandemic situation.

The issue of unavailability of electricity in many parts of Pakistan can be resolved by the usage of solar panel generated electricity, Uninterruptible Power Supply (UPS) and generator sets. This solution is somehow expensive however, it compensates for a great deal of power shortage issues.

2.5.2 Lack of High-Speed Internet Access

Like electricity, the Internet is a basic requirement to continue online education during a pandemic situation. Many areas in Pakistan are indigent of internet facilities. Students in remote places may lag academically availability and frequent disconnections due to slow Internet connections or limited access from their homes.

The above problem may be resolved by using 3G and 4G mobile data connections usage. This option provides a bit slower data rate; however, it is a way out of the unavailability of the internet.

2.5.3 Learning Graph

The world was unprepared for any pandemic situation, just like Pakistan. The majority of the instructors, as well as learners, were not trained to utilize the online teaching environment. This change in learning trends badly affected the transfer of education, especially in the initial phase of online learning during the lockdown period in small, as well as metropolitan cities of Pakistan. Almost all the private and public sector educational institutes arranged various training sessions to get their trainers trained for the new online system.

To boost up the learning graph among the learners, an online end lecture feedback survey form or an end lecture ungraded quiz session may help intimate the instructor about the level of understanding of students. This may help the instructor to analyze the current learning status among students and adopt a better online teaching approach.

2.5.4 Practical Education

The online education system is effective for business institutes' education as most of the learning contents are based on theoretical concepts. However, a similar online approach to teaching cannot be adopted by the educational fields such as engineering or medical where the hands-on or practical sessions are mandatory part of lesson plans.

To compensate for the issue of the practical sessions, schools may adopt Augmented Reality or Virtual Reality tools. Not many institutes in Pakistan can afford such facilities. Therefore, Simulator tools may

also be utilized to provide for the provision of understanding in practical based education.

2.6 Discussion on Education Sector

The new trends in education make significant changes in the grades as well as learning of the students. It has been observed by many instructors that the grades of the students are improved as compared to the grades secured during on-campus pre-pandemic education, however, the learning of students and transfer of knowledge does not reflect the same. Two of the reasons observed by the instructors of better grades among all students. The first one is the non-vigilance of examination conduction and the second close ended questioning style. Both these problems, results in achieving higher grades / GPAs among brilliant, above average, average, and below average students. Instructors also observed the unavailability of electricity and/or internet facility, frequent disconnections, and lack of proper training in online schooling are restraining students in the transfer of education. Underdeveloped South Asian countries including Pakistan, India, and Bangladesh where the unavailability and disconnection of electricity and internet service are common problems may go for distance learning. There are various distance learning platforms including Coursera, Udemy, Khan Academy and Edx which are gaining popularity, especially during the COVID-19 period. This platform provides a wide range of degrees as well as certification courses. It may increase the reachability of every learner. Apart from all the facts mentioned, schools, colleges and universities have a greater need to operate with innovative online educational methods.

3 Healthcare Sector During Covid-19 Pandemic And Associated Wireless Solutions

Good health is a basic need of every human being. The COVID-19 outburst acted as a catalyst for use of advanced technologies in the development of smart healthcare applications and automation of healthcare services [6]. Following the outbreak of the pandemic, a larger percentage of people deceased, in part due to a lack of appropriate medical attention, because the healthcare infrastructure was not equipped to handle tragic events. COVID-19 has shown that an excess of patients, a lack of medical facilities, a failure to prevent infection, and a delayed reaction can cause the healthcare infrastructure to collapse, even in the world's most advanced economies. The healthcare sector can be divided into three major application areas; care inside the hospital environment, care in remote areas, and care in case of any disaster/emergency [7]. To improve the hospital services and patient care smoothly during pandemics by proper monitoring, keeping, and managing patient health records along with the best clinical services. Many service providers have turned to information and communication technology (ICT) solutions such as telemedicine e-health or telehealth. Safety and self-measures, according to the World Health Organization (WHO), are critical in preventing the virus from spreading from one individual to another. To prevent viral spread, wireless technology is necessary [8].

According to an independent assessment, about 130 million individuals in Pakistan have extremely limited access to healthcare services. The bulk of Pakistan's population lives in distant and rural regions and lacks access to medical services. Remote monitoring of patients, while they're still in transit, is critical

in this respect. In a study, [9] suggested a paradigm for Remote Patient Monitoring Systems (RPMS) connected with emergent services in Pakistan, given the need of delivering improved healthcare services to patients. This healthcare model keeps track of individuals in real time, including patients and nearby ambulances (with an in-emergency response team and crucial resources) to aid patients by transferring them to the right healthcare center as needed. It assists in minimizing response time while enhancing golden time by immediately engaging an ambulance from the closest place (using geographical and temporal parameters) and avoiding the call center, so avoiding the certain loss of time caused by the traditional technique. The Remote Patient Monitoring Systems (RPMS) has the potential to improve the provision of emergency healthcare services by lowering service times and allowing for more effective resource allocation.

Telemedicine is a means to give better health and medical services to individuals in underserved and inaccessible places. Face-to-face consultation is becoming increasingly valuable because of time and resource constraints, and telemedicine can provide significant savings in the symptomatic process. As a result, current research aims to combine medicine and technology to create a stable system that provides a satisfactory service at a reasonable cost. Various telemedicine approaches include both store and forward and real-time activities. This concept also helped to connect rural hospitals that are tiny and under-equipped with major, well-equipped hospitals and telemedicine facilities in metropolitan regions [10]. Several Pakistani hospitals and doctors use WhatsApp and Skype applications (a free smartphone application that allows instant messaging with pictures and videos) for appointments and consultations. Similarly, MARHAM, a smartphone mobile application investigated the impact of social and mobile media in digitizing the health industry in Pakistan. During the pandemic, MARHAM's social media (Facebook group, Facebook page, and Twitter account) and mobile app assisted 6083 WhatsApp group posts, 1724 tweets, and 1123 Facebook postings [11]. During the lockdown period of pandemic, some other e-commerce (healthcare sector) sites such as dawaai. pk, make it possible for people in Pakistan to buy genuine medicines on prescription and delivered them to their homes [12].

3.1 Healthcare in Pakistan

The healthcare sector in Pakistan has started the use of advanced technologies but to compete with global market trends, it is needed to make use of Advanced Cloud Computing techniques, Artificial Intelligence, 5G communication networks, Multi-Accessing Edge Computing (MEC) / Mobile Edge Technology & Internet of Things (IoT) based 6G technology and Low Energy communication devices including BLE (Bluetooth Low Energy) to guarantee that the information is transferred with minimal loss and provide accurate data in terms of monitoring and surveillance of indoor & outdoor during pandemic situations. In Pakistan, future healthcare services need to work on aforesaid advanced technologies to provide efficient emergency, remote communication/monitoring, drone surveillance and telemedicine services. Figure 4 shows a linear technological growth of a few advanced technologies in the coming decade.

4 Economical Sector

The wireless communication technologies played a significant contribution in rescuing the global economy during COVID- 19 Pandemic. To regulate the spread of COVID- 19, some unusual measures were taken across the globe which causes drastic economic loss. There was a tradeoff between saving more lives vs. saving the economy among the international policymakers. [16]

It was investigated that the major victims of the COVID-19 outbreak are the micro, small & medium-sized enterprises, in comparison to large organizations. Precisely, enterprises faced diversified difficulties such as a decline in demand, raw material scarcity, supply chain disorders, transportation disruptions, logistics, service sector, entertainment & communications, financial services and tourism. [17]

4.1 Economy of Pakistan

Being a developing country Pakistan’s economy is highly vulnerable and unstable. Because of this, it did not have the capacity to absorb the massive disruption and lockdowns caused by the pandemic. The economy was already struggling to sustain but was not in danger of collapse. Pakistan faced the worst economic setback in its history during the COVID – 19 pandemic. [18]

In order to fill the gaps affected by severe lockdowns, there was a need to pledge some strategies by policymakers and practitioners to overcome the impact of the economic destruction due to the pandemic. This paper also focuses on the new dimensions of wireless solutions to the problems aroused during the pandemic which were developed and implemented to stabilize social economy.

4.2 Pandemic stimulated E-Commerce

Due to the movement restriction in the pandemic era, several sectors of Pakistan's economy remain under immense pressure as people started adopting contactless buying and selling modes. Unlike other sectors, the e-commerce of the country has registered a huge boost in sales and the number of registered e-commerce merchants touched new heights.

According to the latest statistics released by the State Bank of Pakistan, the country's e-commerce market has seen an upsurge of growth in the year 2020. The data of the country's central bank showed that the e-commerce revenue increased sharply by 2.3 billion rupees to 9.4 billion rupees in the fourth quarter of the fiscal year 2020, bringing the yearly revenue to 34.8 billion rupees.

The above graph in Fig. 5 shows a noticeable increase in the number of e-commerce merchants registered with the banks when the pandemic began. As of March-end 2021, there were 2,523 registered merchants which continued to grow till date. The above statistical data shows the trust and comfort of the merchants with the banking system. [19]

COVID-19 has pushed people to turn toward online shopping while staying at home. From groceries and household goods to clothing and shoes, from accessories and indoor exercise equipment to electronics

and digital gadgets, purchasers are relying heavily on the digital mode of buying.

Many daily wages people like Plumbers, Electricians, Carpenters, Vehicle Mechanics, tailors, etc were badly affected due to the lockdowns. Tech startups like Helpp and Hukum janab provide the opportunity to earn their bread and butter by using these applications.

Many superstores started giving online purchasing facilities during the lockdown period which were previously working only for walk-in customers like Metro and Carrefour.

Pakistan has a lot of scope in the modern public transportation system, but this area was severely affected during the lockdowns. An application like Airlift express has previously been used only for transportation and parcel delivery services but after the pandemic hits Pakistan this application switched its model from transportation to providing grocery delivery services.

Previously, Foodpanda was offering online food delivery through various restaurants registered on the application. Grasping the advantage of already having wireless infrastructure, they thrived their business by connecting local grocery shops with their platform named Pandamart.

After increasing the popularity of these applications many other people started these kinds of services even without having the facility of internet. Many vegetables/ fruits and meat shops started giving their items just on phone calls.

4.3 Solutions to upgrade Economical Sector

This is particularly essential now that the drive towards the fourth industrial revolution and the internet of things is well underway. Technologies like 5G, artificial intelligence, robotics, block-chain and augmented reality would come to dominate the economic sphere by fueling the industries of the future. Wireless solutions blurred the gap between manufacturing and service to drive economic growth.

Pakistan has to substantially upgrade its digital infrastructure for online transactions and the e-commerce industry. Since the capacity and bandwidth are crucial requirements as most of the traditional businesses are digitalized. The government also needs to encourage people to use digital modes of payment. The modern education curriculum should incorporate the appropriate material of digital literacy to equip the future generation with the evolving trends of the job market. Moreover, the government authorities should incentivize the merchants by offering mobile payments which would be beneficial for increasing the use of e-commerce and digital financial platforms. Lastly, the women entrepreneurs can also be encouraged by upgrading their informal businesses into formal enterprises which can sky high the global economy.

5 Conclusion

This paper reports the role of wireless communication technologies in mitigating the disruptions caused by COVID-19 pandemic. The issues faced by the developing countries have been reported, due to the lack

of facilities and socio-economical luxuries available in the developed world. COVID-19 disruptions in Pakistan have been reported as the case study for this presented work. Advancements and solutions based on wireless and communication technologies have been reported in various fields. The state, disruptions and their associated wireless solutions are reported for education, healthcare and the economic sector.

Declarations

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Conflicts of Interest/Competing Interests

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Data Availability

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Code Availability

Not applicable to this article as no code was used during the current study.

Author Contribution

Engr. Ayesha Rafique: Writing - Review & Editing, Visualization.

Engr. Noreen Akram: Visualization, Writing - Review & Editing.

Dr. S. M. Umar Talha: Conceptualization, Methodology, Validation, Project administration

Engr. M. Umar Khan: Writing- Original draft preparation, Methodology

Dr Razia Zia: Validation, Data Curation

Dr. Muhammad Amir: Supervision, Project administration, Visualization

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Figures

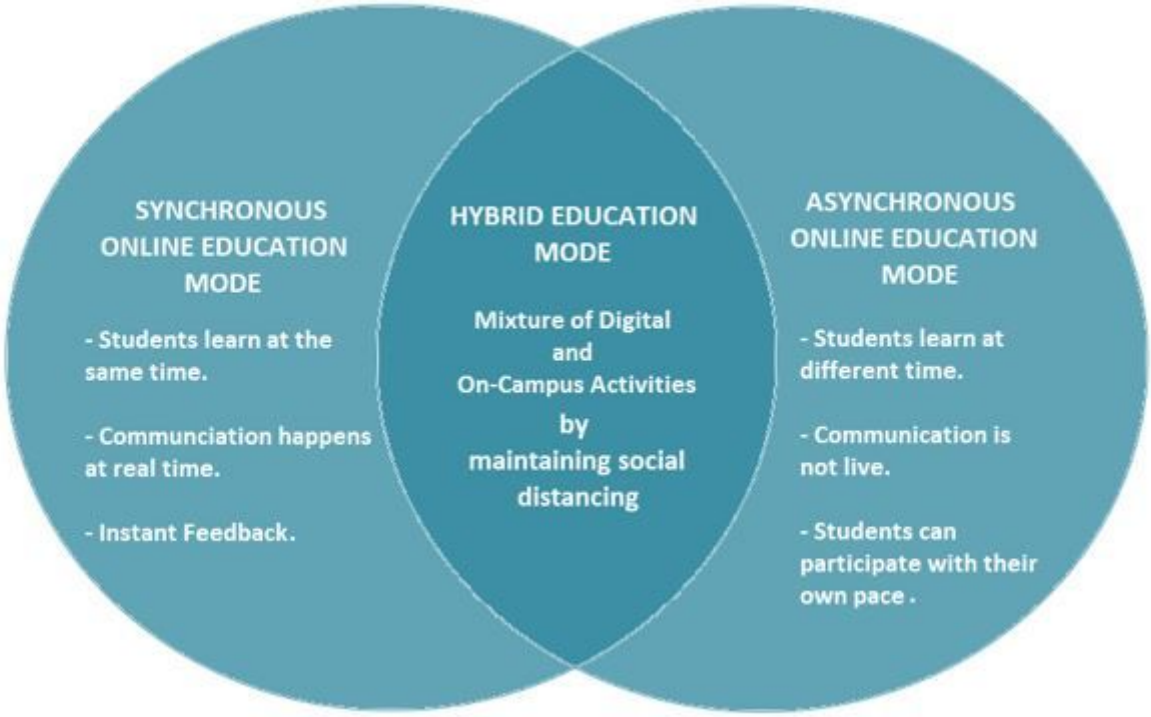

Figure 1

Education modes adopted during COVID-19

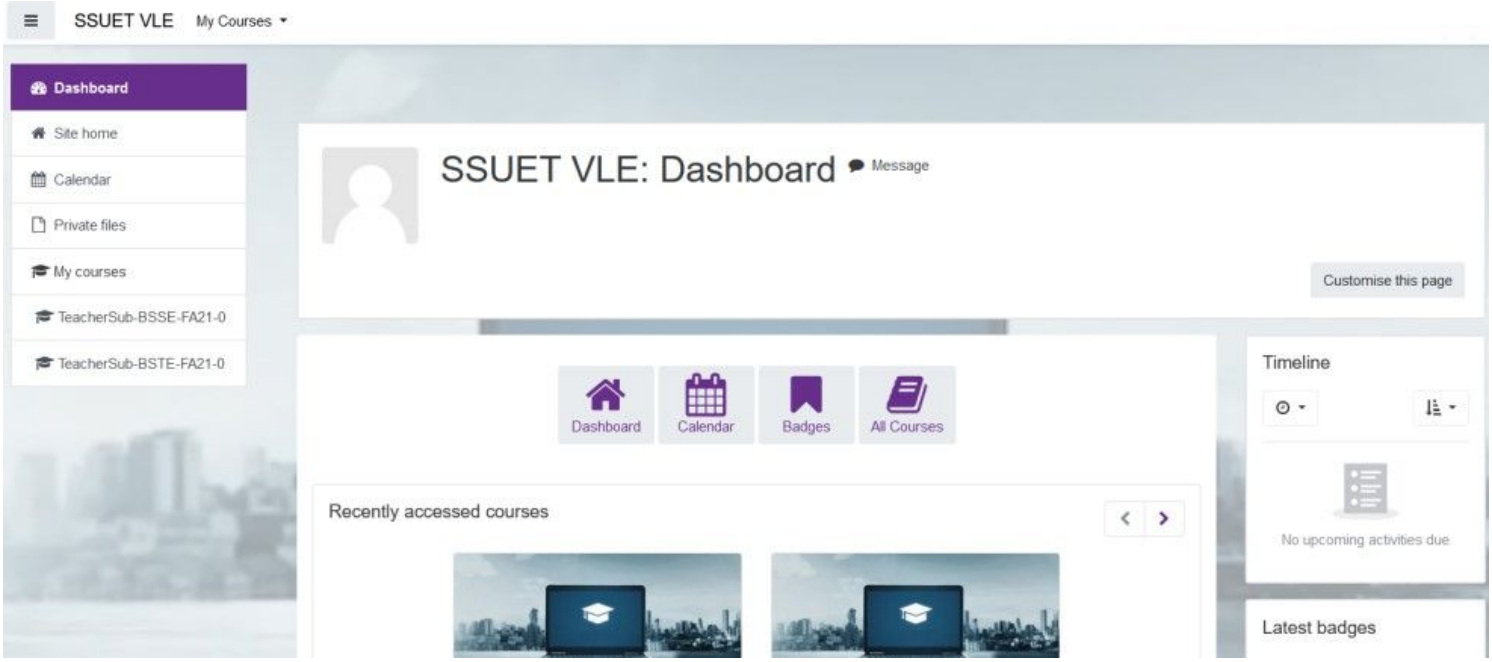

Figure 2

VLE Environment of SSUET

Figure 3

A pictorial representation of the Hybrid Education Mode

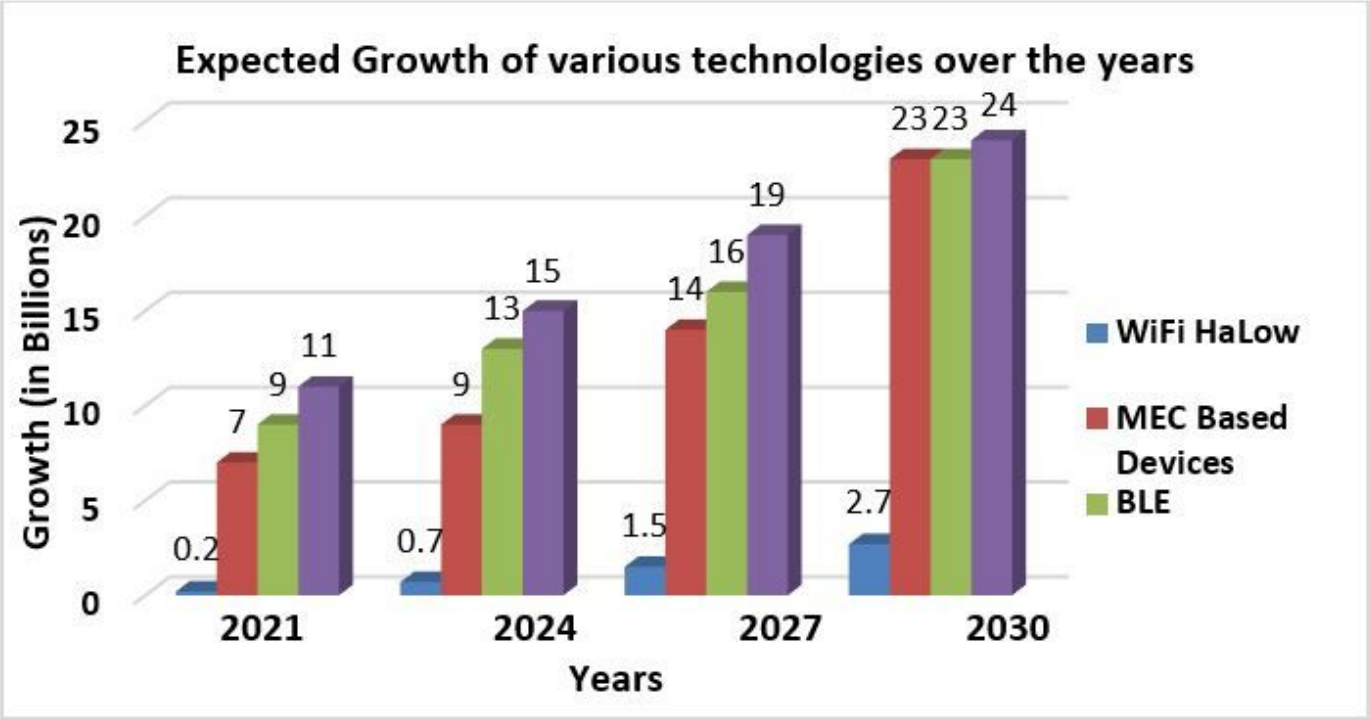

Figure 4

Expected growth of various state-of-the-art technologies over the years [13-15]

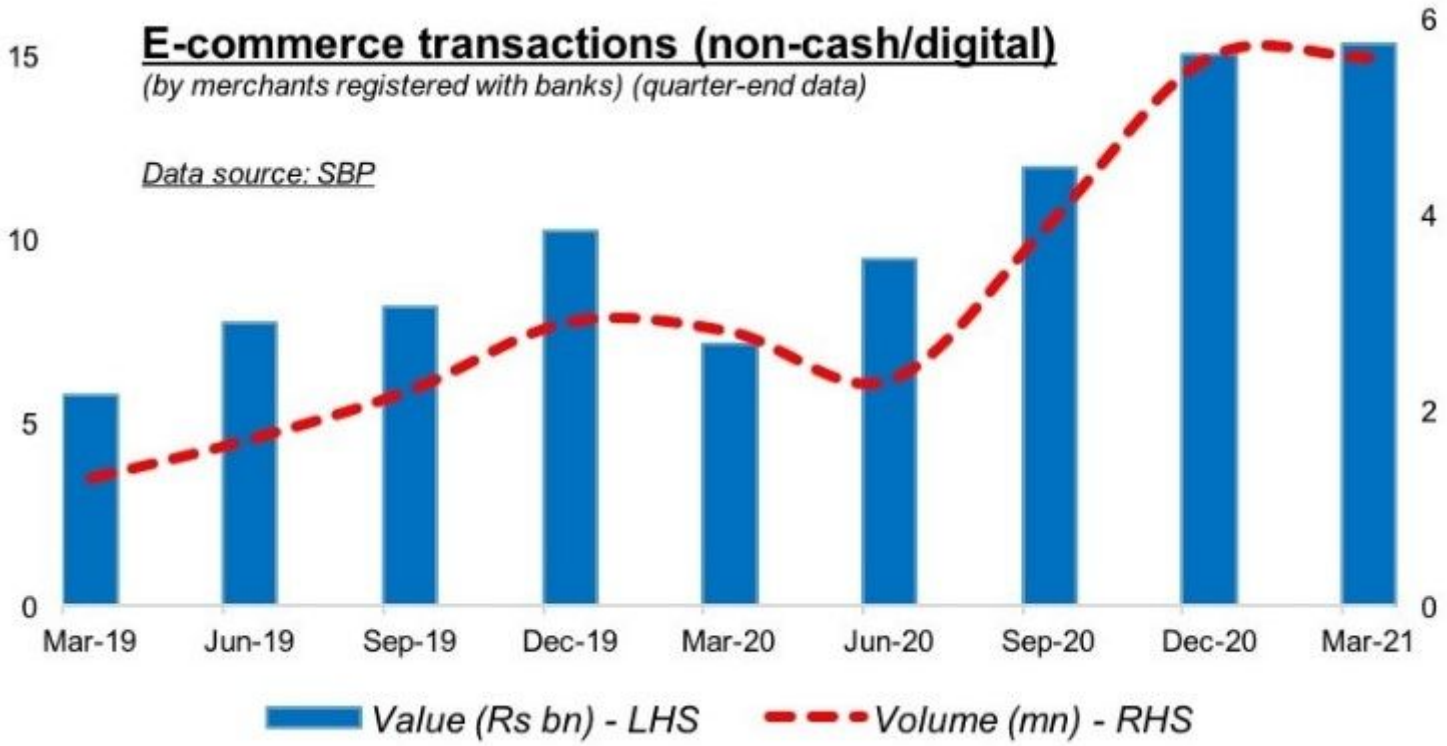

Figure 5

Digital transactions graph from March 2019 till March 2021