Reflecting on the impact of COVID-19 on healthcare and IT sector with special emphasis on India: A collection of multifarious cases with few empirical evidences

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1. Introduction

The ever-growing concern to curtail the blood-thirsty pandemic of COVID-19 has been strongly felt since the death rates started to surge worldwide. After claiming several lives across countries, doctors, scientists and other potential hotshots are relentlessly mulling over strategies to unshackle the world from the hovering shadow of the deadly disease. The adverse effects triggered by COVID-19 are unprecedented and rather uncanny. Jettisoning the global deaths, the pandemic itself has given a lot of headache in terms of plummeting economy, derailing employments, creating personal stresses and blighting several other dimensions of life. Truth to be told, the impact left by COVID-19 will be strongly felt even after its ultimate exit. In spite of a plethora of measures has been taken to neutralize the adverse effects of COVID-19, still the impact has overshadowed and overpowered the measures as the think-tank of scientists, doctors and potential stakeholders still seems befuddled of unshackling the world from the global pandemic and its ill effects. Although the impact of COVID-19 has been thwarted across several dimensions of the economy, the healthcare and technology sectors have witnessed wholesome metamorphosis in its very nature, let alone, functioning. In fact, these two sectors have also been lauded for its impeccable role in shaping up appropriate measures to blunt the adverse

effects of COVID-19 by myriad head-turning innovations in spite of being severely affected by the deadly virus. This is the very essence of the present case where the objective of lies in discussing the effects of COVID-19 on various subsectors of such two major sectors as well as highlighting the several changes experienced by the subsectors.

Although this has been a much talked about topic which has garnered prodigious attention and intrigue in the past few years, there lay several myths regarding the characteristic of the virus itself, let alone, its aftermath. In this light, it is imperative to discuss about the present issues at hand for greater awareness among the masses.

The current case probes into how the different subsectors within the two major sectors of healthcare and technology has been affected by COVID-19. The case is a pioneering effort attempted at deliberating upon such impact in India.

The cascading impact generated by COVID-19 has been felt at every corners of the world. The disease is making broad headlines every day, especially in India and is still claiming numerous lives. The impact of COVID-19 has been enormous in all sectors of the economy in India. But, there is a need to first and foremost reflect on the impact upon healthcare systems and information technology. The reason behind this is that since the virus is a menacing pandemic, its first effect would be on the health of an individual and since the pandemic has compelled government of all countries to enforce lockdowns, the only solace during these testing times lies in the development and innovation of various technologies which can help people out of this despairing hole and keeping the society running and upbeat which otherwise would have come to a complete standstill.

Before getting headway with the principal aspects of the case, it is important to establish the rationale behind undertaking such a case study in India. India is considered to be one of the leading nations of the world and the aura swirling the sacrosanct nation gives the country an enamoring identity and a competitive edge. In a developing country, where hunger and poverty, under-developments and employment crisis has long been a persistent issue to deal with, the outbreak of COVID-19 in the country has given the nation yet another headache. India has been reeling under pressure from the large scale impacts triggered by COVID-19, whether be it, death cases, shrinking economy, poverty and hunger hitting rock bottom, etc. In this context, it is also admirable to think upon the fact that India in spite of a mammoth 130 billion population is managing COVID-19 with aplomb and the some of its technological innovations during this time of pandemic has been head

turning (Wikipedia, 2021a,b,c). To further reflect upon such issues, the present case is a pioneering effort to reflect upon the impact left by COVID-19 on the two major sectors of India which are healthcare and technology. To serve this purpose, a random choice of eighteen subtopics has been made, ten from healthcare sector and eight from the IT sector. Each subtopic consists of a moderately long description of the present scenario and concludes stating the current situations, challenges, adverse effects and benefits.

1.1 Impact of COVID-19 on Healthcare Sector

- *History of COVID-19*

Covid-19 novel Coronavirus is a global pandemic first identified in Wuhan region of China around November 2019 (Liu, et al., 2020). Since its first emergence in China, it later spread to all other countries of the world and by the middle of March' 2020, it was declared as a pandemic by the "World Health Organization" (WHO). Before being declared as a global pandemic, it initially came into existence as an epidemic which was first noticed in mainland China (Bhargava, 2021). Although the emergence of Coronavirus remains a confidential topic of discussion, the topic has gathered a lot of steam in recent times. China's continuous denial of the fact that the virus did not originate from their laboratories or "Huanan South China Seafood Market" and the other few countries persistently accusing China for the origination and spread of virus has created a gargantuan controversy. COVID-19 novel Coronavirus (SARS-CoV-2) is deemed as the next big pandemic after the 100 year old pandemic "Spanish Flu" (Influenza) during the period 1918–1920 (Chaplin, 2020). The virus is like a flu which is highly contagious and blood-thirsty as witnessed by the overall deaths of people all across the world and the existence of active cases globally.

Initially the virus was said to spread by droplets of saliva or discharge out of the nose of a person who is already infected through cough or sneeze. After some time, it was observed that even without cough or sneeze, the virus was spreading from person to person via close contact which made the virus deemed highly contagious. Most people contaminated by the virus will observe mild to moderate respiratory illness in themselves and would not be able to recover with special treatment. Coronavirus is particularly dangerous for those children who fall under the age of 14 years and elderly people above 55 years of age. People who already have medical and health issues like diabetes, cardio syndromes and respiratory problems are prone to develop more serious effects by the disease which also makes them

vulnerable to death. COVID-19 has wreaked havoc ever since its outbreak disrupting economies of all countries and halting the lives and physical as well as mental health of people. One of the striking revelations of COVID-19 has been the myths and facts that has surrounded the disease and generated mixed perceptions among people. One such strong myth was the initial perception of several people who shared a common thought that the disease could be destroyed in hot and humid conditions unlike the cold conditions in which the virus was unstoppable, a manifestation of the people of European and American countries which have a cold climate where several people lost their lives unlike the South Asian countries which have a rather hot and humid climate where the death rates has been low and recovery rate high. However, this perception did not hold true as time passed by, even the people in South Asian countries, particularly, in India, Pakistan and Indonesia fell prey to the virus and thereafter the juggernaut of the disease has been unstoppable.

To curtail the menacing blood–thirsty pandemic of COVID-19, the government of each and every country enforced lockdowns. As a result, it became mandatory that the people would strictly follow certain protocols of COVID-19 and norms of social distancing. Some precautionary measures included wearing of face masks, use of hand-sanitizers, maintaining a safe distance of 2 m or more from each other, restricted gatherings and many more. After the lockdowns were lifted up and the government of all countries slowly relaxed the COVID-19 protocols by allowing gatherings in public places, there has been a rather passive attitude displayed among the people regarding adhering to precautionary measures. Slowly the spread of the virus started picking up pace and cases escalated again, with few countries going into a re-lockdown mode. This is the same case with India after losing close to 3 lakh people.

• *Problems and challenges in manufacturing and supplying vaccines for COVID-19*

Ever since the potential outbreak of COVID-19 novel Coronavirus, the scientists, doctors and other associated medical experts have been mulling over manufacturing appropriate vaccines to blunt and fight the blood thirsty disease and ultimately help the world to get rid of the deadly virus. However, there has been a stiff challenge in the process of identification of COVID-19 vaccines as several problems and challenges have come to the surface. In the backdrop of the current bedlam, there has been a monumental rise in the interest around manufacturing and distribution of effective vaccines for COVID-19. Although few vaccines have been developed, its overall impact

and effectiveness still remains a myth to many. While some people have lauded over its effectiveness while the others have been wary of taking it, as they see it as a potential threat to their immune system.

Several first generation vaccines need "ultra–cold chain" technology and are quite expensive, thereby posing hurdles to global vaccination campaign and in countries that have low and middle level income generation, access to such vaccines remains a big question mark coupled with uncertainty of the effectiveness of vaccines in people of such country. Also, the upsurge in new variants continues to pose major concern over mutating effect. This calls on the part of the government to consistently develop new vaccines and look after the safety, efficacy and quality aspects. Four primary challenges explored in this context are the maintenance of strong "research and development" incentives, conducting "coordinated clinical trials," efficient and transparent authorization of "safe and effective vaccines" and continuous monitoring their impacts (Santos, 2020).

One of the biggest challenge for any government of a country is the proper development, authorization and distribution of COVID-19 vaccines not only in their native country but also to other countries, which implies that COVID-19 vaccines need to be developed continuously, supplied and disseminated across the globe and successfully deployed within the country (Forman et al., 2021). In this light, a major headache lies with the Government of India, to manufacture and distribute as many as 130 billion COVID-19 vaccines taking into consideration its mammoth population which ranks second in the world after China. In this context, it is expected that the government scales up manufacturing capacities and reduce and eliminate hindrances to meet the quantity and timeline of delivery. This calls for large scale faster production of vaccines and efficient supply chain to foster the process. In India, the manufacturing and daily dosage has been slow but is expected to gradually pick up the pace as the laboratories together with its scientists, medical experts and doctors brace up for an excruciating challenge. In India, currently two types of COVID-19 vaccines are being used which are "Covaxin" and "Covishield." India has also line up for Russia's "Sputnik V" which is expected to help its cause in giving large scale doses to its people and on 1st May' 2021, 1.5 lakh doses of "Sputnik V" has already arrived in India (Kumar, 2021).

- *Changes of legislation on clinical trials and re-purposing of licensed drugs for the treatment of COVID-19*

The clinical trial research has been severely affected by COVID-19 pandemic in safe and effective manner. This holds true by looking that trials

frequently deal with populations who are vulnerable to risk of COVID-19. In this light, thousands of trials have already been suspended or completely stopped due to hardships faced during COVID-19 lockdowns. The method of clinical trials is regarded as a premier method for testing and validation of new drugs and therapies. Based on successful trials, new drugs are said to be approved. In fact, it is extremely daunting to look at the number of people involved in a clinical trial. In this context, few adjustments have been made to clinical trials which have simplified the very process and are expected to benefit COVID-19-affected patients in the long haul. Some of the adjustments include the utilization of remote consents, conducting visits of telehealth study and shipment of oral study treatment to the house of the affected patients (Awasthi, 2020). According to the survey of "The University of Texas Southwestern Medical Center" (UTSW), the professionals of clinical research found that the coordinators, managers and nurses of clinical trials experienced positive feelings. Similarly, 90% of respondents witnessed changes which had a positive impact on the safety, treatment procedures and experience of staff and patients. The staff and patients also supported positive COVID-19 clinical research adjustments in the postpandemic era.

There has been much hype and anticipation in the identification of drugs which potentially could be repurposed to wield and cure COVID-19. Drug repurposing refers to a process "by which new therapeutic uses for existing drugs are identified" (Knight, 2021). The process is also referred to as "Repositioning" or "Re-profiling." Currently, there are two categories of drugs that are being investigated for the purpose of repurposing which are drugs that have the capacity to inhibit the Coronavirus lifecycle and drugs that have the ability to blunt the impact of COVID-19 infection (Balfour, 2020). The first category of drugs are antivirals and currently only one such antiviral has been in use for the treatment of COVID-19 and has been proven effective in faster recovery time from COVID-19-affected patients as observed. The name of the antiviral drug is "Remdesivir" which was first developed in the year 2009 to cure Hepatitis C.

Apart from this, a study revealed a panel of 100 molecules having 21 existing drugs which were effective in blunting COVID-19. Two such have already been approved by the US "Food and Drug Administration" (FDA), "Astemizole" and "Clofazimine," which were initially licensed for the treatment of allergies and leprosy. Four of such are working with "Remdesivir" which also includes "Tetrandrine" which was initially licensed for the treatment of malaria. Thirteen of such has been clinically tested and show favorable ability in fighting COVID-19. The second

category of are those which have the ability to blunt the effects of COVID-19 infection. One such category of drugs includes "Glucocorticoids" which is a very powerful antiinflammatory drug that inhibits the generation and existence of T cells and macrophages. However, its benefit in counteracting COVID-19 has come under the scanner as a meta-analysis revealed that it might be detrimental to nonsevere patients, increasing mortality and delay of viral clearance. However, "Drug Safety Research Unit" has opined that the repurposed drug for COVID-19 still needs to undergo a lot of testing to prove its safety and effectiveness. The reviews from their team provided with an overview of the 50 drugs that could inhibit one or more than one steps of the COVID-19 lifecycle and many more that could counteract the deadly infection of COVID-19.

- *Effects of COVID-19 on primary health care*

Primary Health Care forms the backbone of essentials health catering globally as it meets over 80% of the health needs of an individual. It plays a pivotal role in tracking responses to the identification and triaging cases of COVID-19, diagnosis, helps people cope up with anxiety and reduces demand services of hospitals. During the initial outbreak of the pandemic, WHO emphasized on the role and significance of primary health care and provided interim guidelines for appropriate response by primary health care to COVID-19. The guidelines consisted of 6 principles which are deliverance of necessary health services, identification and management of potential COVID-19 cases, averting the risk of spread of infection, ameliorating existing surveillance, strengthen risk communication and engagement of community and provisions related to services of COVID-19.

The providers and facilities of primary health care play an instrumental role in the tough tussle with COVID-19. The cognizance of the GOI along with the governments of various states has been witnessed and they have responded by issuing necessary guidelines to manage both COVID-19 as well as other health cases (Kumar and Kumar, 2021). Such guidelines are in complete parlance with that issued by the WHO. Such guidelines provide a transparent direction to the apparatus of entire primary health care service. Largely because of this, several health care systems have been able to display solidity in the stiff battle against COVID-19. But, some states have struggled in maintaining an appropriate primary health care service largely due to scarce skilled manpower, poor infrastructure and faulty equipment and facilities. In India, that of late COVID-19 cases have escalated and unfolding an uncanny humanitarian crisis which does not augur well. This has triggered an immediate need for a better "primary health care system."

In India, primary health care system is delivered via a complex blend of government setups along with pharmacies and clinics belonging to the private sector. This has been criticized because of poor coordination and fragmentation but an effective coordination between private and public sector could help leverage the existent assets into an efficient COVID-19 plan. These would include improved access to COVID-19 testing, expansion of tele-health, utilization of community health workers, helping people care for themselves at home and providing messages related to clear health. The ultimate aim of primary health care system is to help the world get rid of COVID-19. In India, about 130 million doses being supplied compared to its humungous population of 130 billion, including first and second doses of vaccination, only 10% of the total population have received at least one dose. According to Economist (2020), "with this current pace India is not expected to vaccinate even 70% of its population until the end of 2022." India is one of the largest global vaccine manufacturers, however, due to the disruptions in its supply chain and conundrum in acquiring raw materials are leading to shortages at sites of vaccination and production delays.

To make inroads to this malaise, primary health care is expected to play a key role. Desai et al. (2021) in their study have suggested certain implications in the landscape of primary health care service. Primary health care staff could be trained to administer vaccines safely and responsibly. They can help reduce the hesitation and build trust in both vaccines and health system. Such staff could also monitor for adverse outcomes and ensure that the second doses are powered by data tracking in properly coordinated information system. The increase in donor and funding from the government in supporting vaccine drives provides ample of opportunity to prioritize on quick wins but simultaneously fine-tunes the delivery and underlying capacity of primary health care in India. Stronger primary health care system will help mitigate the load of morbidity as well as mortality from delayed essential care, foster continuance of COVID-19 vaccination, improve baseline population status of health and strengthen health system. Some of the opportunities to strengthen primary health care via COVID-19 response are promoting trust by getting proximate, building better information system and supporting reeling health workforce.

- *Effects of COVID-19 on doctors, medical professionals, nurses and supporting staffs of hospitals*

It is a fact well-documented that during COVID-19, the doctors, nurses, medical professionals and all the associated staff of health sector has been the frontline warriors. They have been relentless when talking in terms of

service to the nation, a strong testimony of myriad such doctors, nurses, medical experts and healthcare staff who have died as they eventually succumbed to the blood-thirsty disease trying to save the common man. Amidst, the unparalleled crisis, the doctors, nurses, medical experts and other staff of healthcare services have faced several challenges in helping reduce the contamination rate, developing strategies, formulating appropriate long-term plans and obviously, continuous quest with scientists aiming to bring out vaccines for treating the disease (Xu et al., 2021). In addition to this, such group of people have also been exposed to tremendous psychological stress, burnout and levels of fatigue and some such medical professionals have committed suicide while the other have also died due to COVID-19 (Shreffler et al., 2020).

In fact, healthcare workers are more susceptible to the risk of COVID-19 than the common people as they are tasked with a herculean challenge involved in treating the COVID-19 affected people as well as travails of managing their own health. Health professionals during these testing times are required to do their work under extreme stressful conditions even without appropriate protective equipment and have been placed with an uphill task of getting involved in tough decision making related to ethical implications.

The boisterous situation has been excruciatingly challenging in the context of humanitarian, vulnerable and low-income nations, who do not have good health systems. Besides, myriad health services related to sexual and reproductive cases have been side-lined which has also resulted in increased maternal mortality and morbidity. It is noteworthy to mention that the impact of COVID-19 on women health care workers have been monumental. Globally, women accounts for 70% of workers in health as well as social sector. They have been placed with a prodigious challenge of leading from the front, whether, at hospitals, at old age homes or at community mobilizing places. In fact, COVID-19 contaminations among female health care workers are twice than that of their male counterparts (UN Women Data Hub, 2020). At least more than 55% of women catering to health care sector have reported more psychological stress levels and burnout when juxtaposed to male workers (UN Women Data Hub, 2020).

• *Socio-Economic Effects of COVID-19 on Migrant Workers*

Talking in the Indian context, where Coronavirus is making major headlines every day and where the GDP has seen a sharp spiral, the lives of low income groups especially the migrant workers has hit a nadir. The enforcement of lockdowns has seen the closure of factories which has posed prodigious

challenges for the migrant workers. There are major socio–economic issues looming over the future of such workers who stay away from their native places and work to earn their livelihood. Migrant workers working in industrial units have been severely affected by their loss of jobs which has snatched their means of livelihood for them and their family, resulting in poverty, hunger, dislocation and death (Yadav, 2020). The COVID-19 lockdown has really hit the manufacturing industries very hard and the effects have been catastrophic indeed, taking into consideration its relevance in contributing to the Indian GDP which is a nifty 20%.

After the announcement of nationwide lockdown in India, India's 40 million migrants had to cope up with new types of challenges (BBC, 2020). Even before the lockdown, the manufacturing industries were not performing well. The impact on the informal sector of manufacturing industries has been more devastating. According to Interact Analysis COVID-19 Insight Service "Global Manufacturing would shrink by −7.5% in 2020 wherein Global Industrial Production will be losing value of almost 2.8 trillion and Global Machinery Production will collapse by more than 11% due to the impact of COVID-19."

In a developing country like India, where the modus vivendi of industrial migrants has not been great, COVID-19 on the socio-economic lives of these workers has had a rather abysmal impact. In this light, when we see the actual picture of migrant workers in India it reveals a whopping 139 million migrants as per the data released by World Economic Forum. As per Wikipedia, most of the migrants predominantly originate from the states of Madhya Pradesh, Uttar Pradesh, Bihar and Rajasthan, while the capital of India, Delhi and the commercial capital of India, Mumbai allure the highest number of migrants according to the 2011 Census of India. Majority of the migrant workers make up for a predominant chunk of laborers who are paid wages on a regular basis, who work in tough conditions of procuring, construction, textiles and various other units (Gopalan-Hema and Misra, 2020).

Truth to be told, myriad workers especially from the regions from Orissa, Jharkhand and Chhattisgarh are also subjected to unfair wages. Most of the migrants are rural natives living in cities as a means to support their livelihood and family. In fact, migrant workers often lack freedom of movement because of their status of immigration and therefore are more vulnerable to exploitation. These workers are so desperate for work that they might even accept basic amenities of life like food, clothing and shelter instead of minimum wages to survive. According to World Bank, "India's 40 million

migrants are facing the major brunt of the situation." The multiple hardships faced by the migrant workers in India have been one of the most ignominious scenarios ever witnessed in the socio-economic life of Indian workers. Their pathetic condition after being unemployed and dislocated has been a major talked about issue, which resulted in poverty, hunger, starvation, exodus from workplace-to-home, physical exhaustion, accidents, brutal assaults by the policemen, refusal of timely medical attention, suicides and deaths.

The global pandemic left the world reeling and its menacing aftermath is still being experienced by the migrant workers. The lockdowns meant shutdown of industrial units which resulted in massive unemployment crisis among the migrants. It leads to food shortages. While ration was distributed to the poor people, the migrants were deprived of food largely due to the norm of area specific ration cards or other government documents like Aadhaar Card. The scenarios were quite devastating as workers were clearly starving out of hunger. It resulted in the migrants taking a walk from their workplaces to their native regions. Complete lockdowns meant no means of transportation of any kind as a result the migrants had to walk thousand kilometers. Many of them did it while remaining hungry and thus there were massive violations in the rules of social distancing as they were traveling in large groups. The results of such exodus were mostly physical exhaustion and rapid spread of the menacing virus. Furthermore, to add to the woes of such workers, many such workers were arrested by the police for violation of laws, some were brutally beaten up by the police, some died out of physical exhaustion and many workers died to due accidents faced during their journey back home (Aravind, 2020).

Finally, the government came to the forefront to tackle the challenging issues of these stranded migrants of various states. Over 45 lakh people were provided facilities of being ferried back home through the arrangement of over 4000 "Special Shramik Trains" which started on 9th May 2020. However the poor management of the government resulted in the delay of such train and also inadequate providence of food and water to the migrants. In fact, one of the reasons in the surge of COVID-19 cases in India was largely due to the implementation of the initiative of "Special Shramik Trains." Likewise, bus facilities were also arranged to help the migrant workers travel to their home. This initiative was greatly adopted and implemented with great conviction by Bollywood actor Sonu Sood who provided food, water and help travel thousands of migrants from cities to home. The migrants were also provided facilities like food and shelter from the National Disaster Relief Fund (NDRF) as per the directives of Home Ministry given to all

states. Thousands of relief camps had also been set up by the government of different states in collaboration with the NGOs, which provided food and shelter to lakhs of migrant workers as well as adequate quarantine measures (Londhe, 2020).

The Central Government had earlier released a whopping "Rs. 11,092 Crore to states and UTs under NDRF," to provide facilities like food and appropriate shelter for migrants. For providing employment opportunities and wages to workers, the "average daily wages under the MGNREGA" were increased to Rs. 202 from previously Rs. 182 to help the providence of job and wages to such migrant workers ably backed and supported by Rs. 1000 Crore from "PM CARES Fund." The Finance Minister, Mrs. Sitharaman also announced free ration for 80 million migrant workers by spending an eye-twitching ₹35 billion. In addition to this, the GOI had also launched the "Garib Kalyan Rojgar Abhiyaan" endeavor to blight the menacing effect of COVID-19 on migrant workers. This endeavor is actually a rural public works scheme launched with an initial funding of Rs. 50,000 Crore for a mammoth 116 districts in 6 states.

- *Psychological Stress effects of COVID-19 on human beings—Empirical Analysis*

It is a no-brainer that the COVID-19 has taken a prodigious toll on the mental health of human beings. It all started with the initial COVID-19 lockdowns in 2020, where people were instructed to adhere to strict quarantine policy of being forced to stay at home and prohibited visiting outdoors. After the lockdowns were lifted up, people have been instructed to adhere to the COVID-19 protocols of safety rules and social distancing. To add to the extra unaccustomed burden on people, further restrictions were placed in the operations of businesses and manpower at work.

Moreover, the COVID-19 lockdowns has been a nightmare for every individual and a devastating force for disrupting businesses, economies, health and mental well-being. People belonging to the low-income groups and middle-aged income groups have been given a lot of food for thought as their ways of income has been snatched or otherwise shrinked. Even for rich businessmen, dealing with psychological stress has been a major issue. In addition to this, people belonging to other professions like teaching, medical service, entrepreneurship, service, etc. all have experienced psychological stress to some extent (Singh et al., 2020). Many people have also committed suicide since they were not able to deal with psychological stress that came their way. Therefore, it becomes utmost essential to discuss about the topic of psychological stress effects of COVID-19 on human beings.

To serve this purpose, 250 people belonging to the state of West Bengal, living in various districts like Kolkata, Burdwan, Birbhum, Howrah, Hooghly, North 24 Parganas, and South 24 Parganas have been surveyed, and the most dominant factors of psychological stress have been explored with the help of Exploratory Factor Analysis by the use of IBMs SPSS version 23. The respondents are employed at various professions and belonging to various age categories. We have analyzed the data in the forthcoming paragraphs as well as the key factors of psychological stress have been highlighted.

From Table 1, we observe the demographic statistics which is distributed across gender, age, occupation and income.

Conducting an exploratory factor analysis is crucial to explore the relevant factors that reflect the various determinants of psychological stress and social stress. However, before, that the "KMO and Bartlett's Test of Sphericity" has been conducted for checking whether that the sample size is adequate, which will further indicate if it is worthwhile to run a Factor Analysis (Frost, 2020) (Table 2).

Table 1 Demographic statistics.

Demographic construct	Classification	Population statistics	Percentage
Gender	Male	140	0.56
	Female	110	0.44
	Total	**250**	**1.00**
Age	Below 18	16	0.06
	18–24	70	0.28
	25–34	82	0.33
	35–44	44	0.18
	45–54	28	0.11
	Above 55	10	0.04
	Total	**250**	**1.00**
Current Occupation	Student	79	0.32
	Service	85	0.34
	Business	38	0.15
	Others	48	0.19
	Total	**250**	**1.00**
Monthly Income	Less than 10,000	36	0.14
	10,001–25,000	96	0.38
	25,001–50,000	89	0.36
	50,001–100,000	24	0.10
	Above 100,000	5	0.02
	Total	**250**	**1.00**

Authors' own calculations.

Table 2 KMO and Bartlett's test of sphericity.

Kaiser-Meyer-Olkin Measure of Sample Adequacy	0.804
Bartlett's Test of Sphericity Approx. Chi–Square	784.369
df.	9
Sig.	.000

The "KMO Bartlett's Test of Sphericity" gives confirmation to the fact that running the Factor Analysis test was appropriate. The ideal values should exceed 0.6, which is explained by the "KMO Test Statistic" reporting figure of 0.804 (>0.6). The significance shows a value of 0 ($P = .000$, $P < .05$). This is a confirmation to the fact that Factor Analysis can be performed.

The above table (Table 3) shows us Factor Analysis conducted obtaining a TVE (Total Variance Explained). According to the TVE, results highlight the number of factors obtained with the condition that their Eigen values are greater than 1 (Eigen value >1). As we move down the table (Table 3), it is observed that Eigen value decreases. Hence, the Eigen values falling below 1 are not reported and taken into consideration (Sevincer et al., 2017). It is proved by the Component 1 and Component 2 accounting for and of the total variance explained respectively. Principal Component Analysis helped to extract the variables according to the requisite of the Eigen values are greater than 1 (Eigen values >1).

Table 3 Factor analysis.

	Initial eigenvalues			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.214	46.820	46.820	3.105	34.500	34.500
2	1.100	12.220	59.040	2.319	25.766	60.026
3	0.876	9.733	68.733			
4	0.749	8.322	77.095			
5	0.610	6.777	83.872			
6	0.531	5.900	89.772			
7	0.407	4.522	94.324			
8	0.321	3.566	97.890			
9	0.192	2.110	100.00			

Extraction Method: Principal Component Analysis.
Based on authors' own calculations.

Table 4 Rotated component matrix.
Rotated component matrix[a]

	Component	
	1	2
Frustration	0.728	0.156
Job Security	0.749	0.178
Financial Security	0.547	0.319
Emotional Drain	0.595	0.371
Lack of Self–Esteem	0.497	0.492
Extreme Alertness at Workplace	0.593	0.47
Lack of Leisure Activities	0.272	0.735
Relationship with Family Members	0.432	0.618
Lack of Outdoor Activities	0.816	0.168

[a]Rotation converged in 3 iterations.
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Authors' own calculations.

Table 4 shows the Rotated Component Matrix according to which the variables would get accommodated in the factor loadings, thereby showing the final results. The component may be arranged in the following manner (Table 5).

The 9 variables are disintegrated into 2 factors which we have renamed as Component I and Component II. Component I has been renamed as Psychological Stress and Component II as Social Stress.

There were an aggregate of 9 key dominant factors of psychological stress that have been identified which are frustration, job security, financial security, emotional drain, lack of self–esteem, extreme alertness at workplace, lack of leisure activities, relationship with family members and lack of outdoor activities.

Table 5 Arrangements of components.

Component I	Component II
Frustration	Lack of Leisure Activities
Job Security	Relationship with Family Members
Financial Security	Lack of Outdoor Activities
Emotional Drain	
Lack of Self–Esteem	
Extreme Alertness at Workplace	

Authors' own calculations.

- **Effects of COVID-19 on kids and youth**

The pandemic of COVID-19 has taken a serious toll on both physical as well as mental health of people. The kids have been jettisoned from an otherwise a very jolly and playful environments of the yesteryears. Given their active modus vivendi of rush hours during school time, tiffin time or the playground and parks accommodated with them, since the outbreak of the pandemic the kids have been deprived of such pleasures which has made their lives quite monotonous and their personality close to being an introvert. According to Human Rights, 2020, due to COVID-19 pandemic, kids are getting schooled at home by online classes which itself is quite tough on them. Many kids who belong to weaker sections of the society have suffered because of this noticeable change in conducting studies through online mode. Particularly, those kids who stay in remote villages and receive education from local schools and private schools have severely suffered the wrath of the pandemic. Adding to their woes, the quarantines and precautionary measures like following norms of social distancing, wearing of masks, frequent sanitization of hands and outdoor activities being snatched away have been quite ruthless.

The impact of the COVID-19 pandemic has also severely hit the youth. Given the hectic modus operandi of the young people, whether be it hitting the gym early morning, or going to college, or going for work, either indulging in outdoor activities or hanging out with friends in the late evening, everything has been snatched away by the pandemic. Although people are working from home and even undertaking online classes to keep afloat their desire for learning and getting educated, they have clearly struggled to keep themselves upbeat in outdoor activities which are seen as a potent part of the schedule of the present day youths. Lack of outdoor activities or leisure time is having an inexorable impact on the physical and mental health of the young people (Bahl et al., 2021).

- **Health and safety best practices for use in public spaces during and after COVID-19**

The health and safety of people during COVID-19 era and even in the post-COVID-19 period is utmost essential and cannot be compromised on any way. The government of all countries has established certain rules to be followed by their citizens at public places. Wearing of masks/double-masks, sanitization of hands, maintaining of 2 m or more distance from each other, etc. are some of the precautionary measures are being relentlessly practiced by the people in public places. Besides, governments have imposed certain restrictions on travel ban from country to country and a quarantine period of

14 day or more for people who visit their territories from another country. The governments have also imposed restrictions on gatherings both social and political. The places of worship like temples, churches, mosques and other have observed a temporal close and religious gatherings have been strictly prohibited. In countries, where COVID-19 cases are minimal and manageable, the religious gatherings have been restricted to a certain limit. Tournaments like cricket, football and others continue to take place but there are restrictions in crowd capacity in stadiums. The rules are particularly harsh for the players as they are required to train only in few numbers and in batches. Strict quarantine protocols are being practiced by them especially remaining fully inside their respective hotel rooms which is mentally tough for any athlete. Restaurants, hotels, clubs and other places of visit have been temporarily shut or are running with very low crowd capacity. Strict safety protocols of COVID-19 are being followed there which involves wearing of masks, thermal testing before entering and sanitization of hands (World Health Organization, 2020).

- *How COVID-19 pandemic has affected global healthcare and its implications for future of healthcare*

The emergence of novel Coronavirus has changed the trajectory of the whole world. The wrath of the pandemic has got reeling all major sectors of an economy. The jolts triggered by the pandemic has been felt severely all across the globe, especially in the ambit of healthcare sector. It is quite astounding to notice the changes in global healthcare sector because of a contagious life threatening disease. The pandemic has changed the very roots of functioning of a healthcare sector and even poses a plethora of dimensions by which such changes could stay even after the pandemic gets over. Governments and investors are now openly encouraging healthcare spending and exploring new multilevel delivery strategies. The gap between healthcare delivery and public health is now getting bridged. Healthcare institutions are leading the bandwagon for battle against COVID-19. Business models are being reshuffled, supply chain are being fine-tuned, exquisite attention is being given to training and development, etc. Strategic alignment between healthcare systems and clients has been a blessing in disguise as partners are moving in different trajectories but eventually arriving in a same common place. Healthcare system is going largely "digital" which is another feather in the cap for the sector taking into consideration even the small players who are providing robust healthcare services by proper digitalization of their contents (Hassoun, 2021).

The COVID-19 era is a new dawn and a learning curve for the global healthcare sector. As there has been an exponential increase in the healthcare

spending for COVID-19, companies that are conducting research, producing test kits, developing vaccines and supplying medical equipment. A key reason to this is that the government would not invest only in damage control but also aim to prevent the resurgence of the COVID-19 pandemic. In this light, it becomes vital to deliberate on the short-term, medium–term and long-term implications of COVID-19 on healthcare sector (Infosys BPM, 2021).

Short-term Implications: The next six months would be crucial for managing this pandemic. There will be huge pressure on the infrastructure of hospitals and clinics. Non–immediate surgeries will see a decline and business should be prepared for delays in payments largely because of the inconsistencies in the proportion of demand and supply.

Medium-term Implications: The only standout points for healthcare system lies in the upsurge in investments in primary and intensive care. Financing pressure is going to be humongous for healthcare providers and other public players. However, things are expected to be back to terms once the outbreak flattens.

Long-term Implications: The governments together with the organizations are required to reprioritize the plans of long term healthcare at a macro level. The post-COVID-19 era is likely to witness the healthcare sector adopt new concepts like telehealth, remote care, and other myriad digital solutions for enhanced patient care.

1.2 Impact of COVID-19 on Computer and Informatics

• *Role and impact of digital technologies during COVID-19*

The global crisis triggered by the COVID-19 pandemic is a multifaceted one, which has seen uncountable deaths and devastating socio–economic dimensions. The most severe setback witnessed during the COVID-19 pandemic has been the lockdowns which has plummeted all major sectors of the economy. To cope up with this malaise and keep abreast during these testing times, most of the sectors are switching to "digital" way of doing business. Digital solutions are playing a pivotal role not only in the landscape of scientific research but also helping continue the economic endeavors and delivery of important services which also includes healthcare and education. New tools like "COVID-19 information portals," hackathons, e-services, virtual consultations regards to medicine and self-diagnosis applications and many other digital technologies have been put in place to cope up with the challenging times. It has been observed that the adoption of digital technologies during COVID-19 pandemic has accelerated and escalated compared to the

past years and that many of such changes are here to stay for long term (LaBerge et al., 2020). Investments in digital initiatives has also increased. The quantum leap taken by the adoption of digital technologies at both organizational as well as industrial level has been phenomenal. Consumers have been witnessed to switch on to online channels. Most notably, the adoption of digital technologies have been twice as much in sectors like healthcare and pharmacies, professional and financial services. Similar escalations have also been observed in the digitization of core internal operations and of interactions in supply chain management. The largest changes are most likely to stay for a long term. A primary reason for this is seen the heavy investments made in digital technologies which has eviscerated some of the bottlenecks of the virtual world. Some other reasons are cost–effectiveness and meeting customer needs quickly (Zhenmin, 2020). Besides, investments in data security and artificial intelligence are also being made to help organizations be in a better place compared to the past days. E–learning, e–healthcare services, e–business, e–marketing, e–commerce, e–banking, etc. are some of the most impeccable methods in which digital technologies have played a gargantuan role.

- ***E-learning during COVID-19—Empirical Investigation***

One of the spectacular advancements in the landscape of technology has been the successful integration of information and communication technology in the teaching-learning process which has established itself as an important medium of instruction delivery. Institutions worldwide are now blending information and communication technology with traditional modes of instruction delivery in order to ameliorate the teaching-learning process. Such innovation in technology has made an inexorable impact on the landscape of education where institutions at the present era are witnessed to have a penchant toward e-learning.

Undoubtedly E-learning is fast gaining the upper hand and is being embraced prodigiously during this time of this ongoing COVID-19 pandemic. E-learning is commonly known as online learning or open learning and has its association with advanced learning technology (ALT), which deals with both technologies as well as learning methodologies using multimedia technologies. Truth to be told, the advent of distance education marked the turning point in the milieu of education as it paved the way for e-learning. E-learning overcomes certain barriers like attendance, traveling and costs. It also allows higher participation and better interaction. E-learning is facilitated completely online via multimedia technologies like video-conferencing, chat rooms, computer based communication, e-mail,

electronic forums, etc. E-learning also supports a plethora of e-resources that can be accessed at any time by the students, teachers and other professionals, thereby, strengthening the teaching-learning process. The urgent need and ineluctable relevance of e-learning has been strongly felt in recent times after the emergence and potential outbreak of COVID-19 pandemic wreaked havoc. The government of all countries enforced lockdowns to curtail the deadly virus and as a result is stymied the ever smooth trajectory of education. India was no different as the lockdowns enforced from the middle of March 2020 brought the whole country and all external activities to a standstill. This proved to be a deadly blow for the students and their future keeping them at bay from their education and thus a cloud of uncertainty was hovering around. Soon after, the institutions in India resorted to e-learning and granted permission to all schools, colleges and universities to conduct online classes for their students to keep the sacrosanct element of education afloat. It has been witnessed that both the students as well as the teachers have embraced the concept of e-learning with mirth during these testing times (Mitra et al., 2021).

The attitudes and behavior of students toward e-learning seems to be an intriguing domain of study and research. To serve this purpose, a total of 352 respondents studying in different colleges and universities in the state of West Bengal have been surveyed. The survey areas include Kolkata, Burdwan, Howrah, Hooghly and South 24 Parganas. The theoretical model of "Technology Acceptance Model" (TAM) developed by Fred Davis (1989) has been adopted to address the present issue (Fig. 1).

The following hypothesis has been framed:

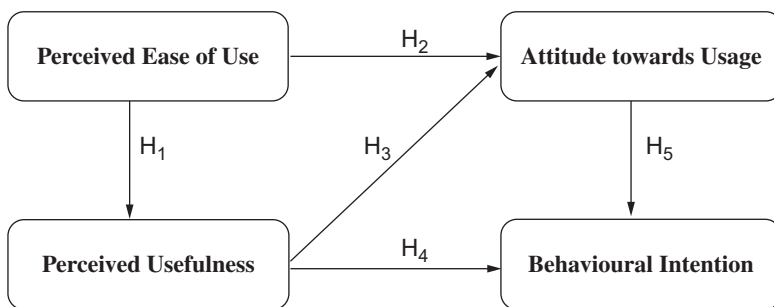**H_1. There is a significant relationship between Perceived Ease of Use and Perceived Usefulness**

Fig. 1 Research model. *(Self-developed by authors.)*

H_2. **There is a significant relationship between Perceived Ease of Use and Attitude towards Usage**

H_3. **There is a significant relationship between Perceived Usefulness and Attitude towards Usage**

H_4. **There is a significant relationship between Perceived Usefulness and Behavioural Intention**

H_5. **There is a significant relationship between Attitude towards Usage and Behavioral Intention**

The questionnaire which has been administered online to the students consist of questions which are based on the constructs of TAM which are "Perceived Ease of Use, Perceived Usefulness, Attitude towards Usage and Behavioural Intention." For the purpose of data analysis, IBM's SPSS version 23 has been used. The results of the findings has been represented below, one by one.

1.2.1 Reliability analysis

A reliability test has been conducted to check if the variables of the research model, viz., "Perceived Ease of Use," "Perceived Usefulness," "Attitude towards Usage," and "Behavioral Intention," fit perfectly in the question-naire by the use of Cronbach's Alpha score. Accordingly, the threshold limit should be greater than 0.6 (Bravo and Potvin, 1991), it is observed that in this case, the figure report 0.763, indicating that all the variables fit perfectly in the questionnaire (Table 6).

1.2.2 Correlation analysis

After conducting the reliability analysis, it is vital to find out the relationship between the 6 factors as well as to examine the hypotheses of our proposed research model. To serve this purpose, we have conducted a correlation test by using SPSS version 23. Table 7 shows that the correlation between PEOU, PU, ATU, and BI is positive and significant, thereby confirming that our original hypotheses made in the literature are related to TAM. The correlation statistics has been presented below.

Table 6 Cronbach's alpha.

Cronbach's alpha	Cronbach's alpha based on standardized items	N of items
0.763	0.763	17

Table 7 Correlation test.

Factor	PEOU	PU	ATU	BI
PEOU				
Pearson Correlation		0.628[a]	0.705[a]	0.712[a]
Sig. (2-tailed)	1	0.000	0.000	0.000
N		352	352	352
PU				
Pearson Correlation	0.628[a]		0.654[a]	0.728[a]
Sig. (2-tailed)	0.000	1	0.000	0.000
N	352		352	352
ATU				
Pearson Correlation	0.705[a]	0.654[a]		0.749[a]
Sig. (2-tailed)	0.000	0.000	1	0.000
N	352	352		352
BI				
Pearson Correlation	0.712[a]	0.728[a]	0.749[a]	
Sig. (2-tailed)	0.000	0.000	0.000	1
N	352	352	352	

[a]Correlation significant at the 0.01 level (2-tailed).
Authors' own calculations.

1.2.3 Regression analysis

To further strengthen our research findings, we have also conducted a regression statistics to test the different proposed hypothesis.

First, we examine the relationship between H_2 and H_3.

As we can see from Table 8, the value of R square indicates that the two predictors (PU, PEOU) explains 71.7% variations in ATU. It explains the rationality of this model, although there might be other oblivious factors having an impact on the respondents' ATU. The standardized coefficients (β) shows that PU ($\beta=0.553$) have a larger impact than PEOU ($\beta=0.381$). Also, the Sig. indicates that both of the predictors have a significant and positive impact on ATU scores being less than 0.001 level.

From Table 9 it is confirmed that all the two predictors namely PU and ATU had a significant and positive influence on BI, with ($\beta=0.594$) and ($\beta=0.603$) respectively for each predictor. Each of the four predictors have Sig $=0$.

Finally, we conduct a regression analysis to examine H_1.

Finally, one more determination of a regression model was done to test our fourth hypothesis, i.e. influence of PEOU on PU. As evidenced from

Table 8 Regression test.
Predictors: PEOU, PU → Dependent variable: ATU

Model summary					
Model	**R**	**R square**	**Adjusted R square**	**Std. error of estimate**	
1	.876[a]	.717	.713	.60436	

Coefficients[b]					
	Unstandardized coefficients		**Standard coefficients**		
Model	**B**	**Std. error**	**Beta**	**t**	**Sig.**
1 (Constant)	.378	.193		1.534	.143
PEOU	.363	.050	0.381	6.826	.000
PU	.587	.057	0.553	10.342	.000

[a]Predictors (constant), PEOU, PU.
[b]Dependent variable: ATU.
Authors' own calculations.

Table 10, the value of R Square is 0.687 which represents that PEOU explains 68.7% variations in PU. We also notice that Standard Coefficient value is ($\beta = 0.381$), PEOU had a significant and positive impact on PU.

Hence, our proposed research model along with the hypotheses are rightly proven correct as evidenced by the robust examination and analysis.

Table 9 Regression test.
Predictors: PU, ATU → Dependent variable: BI

Model summary					
Model	**R**	**R square**	**Adjusted R square**	**Std. error of estimate**	
1	.895[a]	.724	.707	.57964	

Coefficients[b]					
	Unstandardized coefficients		**Standard coefficients**		
Model	**B**	**Std. error**	**Beta**	**t**	**Sig.**
1 (Constant)	.456	.177		1.749	.092
PU	.483	.068	0.594	6.554	.000
ATU	.599	.072	0.603	8.688	.000

[a]Predictors (constant), PU, ATU.
[b]Dependent variable: BI.
Authors' own calculations.

Table 10 Regression test.
Predictors: PEOU → Dependent variable: PU

Model summary				
Model	**R**	**R square**	**Adjusted R square**	**Std. error of estimate**
1	.809[a]	.687	.690	.56438

Coefficients[b]					
	Unstandardized coefficient		**Standard coefficients**		
Model	**B**	**Std. error**	**Beta**	**t**	**Sig.**
1 (Constant)	.378	.193		1.534	.143
PEOU	.363	.050	0.381	6.826	.000

[a]Predictors (constant), PEOU.
[b]Dependent variable: PU.
Authors' own calculations.

According to our research findings, Perceived Usefulness (PU) had a significant impact on Attitude toward Usage (ATU). It was also observed that PU was significantly related to Behavioral Intention (BI). The reason behind this could be that students are willing to adopt a beneficial technology that could make learning more convenient during the pandemic situation. Perceived Ease of Use (PEOU) was significantly related to ATU of online teaching. The findings of the present research study also proved that PEOU had a strong influence on PU, suggesting that providing adequate user training is vital for fine-tuning the students' perception about the usefulness of a technology which is quite unique. Ultimately, we comprehend that ATU has been prodigious in shaping up the BI of students toward e-learning as both psychological and physiological faculties are a nifty driving force in the development of perceived likelihood of students.

- **Digital transformation of the healthcare sector triggered by the COVID-19 pandemic**

The greatest exemplification of digital transformation in the healthcare sector during COVID-19 is the operations of telemedicine or contactless healthcare services (Jason, 2020). The various technological innovations resulting from the COVID-19 is using the existing tools or standards and repurposing them. The influx of patients in hospitals had earlier exposed the loopholes in the current healthcare system. This primarily ushered an astounding digital transformation of the healthcare system aiming at improved care, reduction of operational cost and time saving treatments.

Tele-consultation became a norm as it allowed physicians to attend more patients via virtual platforms and even connect to physicians in foreign countries. There was a steep rise witnessed in the adoption of various tele-consultation start-ups like Practo, Teladoc Health, MeMD, Doctordemand, Kry, and accuRx. This also boosted the rise in adoption of video-conferencing software like Zoom, Microsoft Teams and Google Duo. Tele-consultation has also minimized the medical expenses for patients. A consumer survey was conducted by American Well which reported that 61% of those people who were willing to switch to tele-consultation would actually do it as they saw it as more convenient option and quicker service. In comparison, 54% would adopt it to save money. Slowly and steadily, there were various e-health apps most notably "Aarogya Setu" app of India which provided services of detecting COVID-19 contamination. It was a special "syndromic mapping and self-assessment" digital service which was developed by the National Informatics Centre. The app witnessed installations of more than 100 million per day. It was lauded by the WHO. Now, the healthcare sector seems to be improvising further as digital transformations are speaking heavily for it. The treatment of COVID-19, reservation of beds for COVID-19-contaminated patients, and vaccination drives are all taking place by primarily by the use of digital services, either by visiting the website or app and filling in the required information (Bijlani, 2021). It is also noteworthy to mention about the impeccable role played by Artificial Intelligence (AI) during this pandemic. A detailed study about the use and benefits of AI to provide the required IT infrastructure amidst COVID-19 pandemic has been explained in the next subsection of the study.

• *Benefits and use of AI to provide IT infrastructure during COVID-19*
While the role of tele-consultation largely bridged the gap between the patients and the doctors, a major conundrum existed in dealing with non-COVID patients as most of the doctors were seen dedicating their entire time dealing with COVID-19 patients. The integration of AI with medical systems brought a seismic shift in the IT infrastructure and the overall healthcare system during COVID-19. One of the strongest benefit obtained by the use of AI is that it can analyze medical data very fast and produce an output that can help doctors in the final decision. This is very crucial as many errors would otherwise be attributed to oversights in a rush. AI is also being used for risk prediction, diagnosis, treatment planning, exploring and manufacture of drugs and study of various diseases. One of the most significant role of AI in the IT infrastructure during this pandemic is its impregnable help provided by auto-learning from the data available to

make accurate predictions. Start-ups and educational organizations like DarwinAI, Qure.ai, 1Qbit, and COVIDSWIFT made AI-rooted solutions within reach of doctors. Besides, AI also accelerated the process of drug development and vaccination. It also helped the researchers to understand the anatomy of the virus and predict the determinants which would generate an immune response (Toews, 2020).

Start-ups consider two trajectories for swift vaccine development: the first, repurposing of existing drugs and second, the development of new vaccines. The start-ups involved with the former are BenevolentAI, Cyclica, Innoplexus, and Deargen, while Iktos, Exscientia, Insilico Medicine, and SRI International. Pharmaceutical companies like Pfizer, Sanofi, AstraZeneca and GSK have also collaborated with these start-ups to accelerate the development of vaccine, which is considered to be one of the swiftest feats in the history of medicine. Start-ups like Soporis Health, Artelus, and Sensely are using AI to monitor and study the medical history of the patients and symptoms for providing predictive feedback about a person's health (Toews, 2020). Such head turning solutions are showing the picture of the future of telemedicine and access to health that are capable of reaching out to patients before they themselves find the urgency for medical help.

- ***Benefits and use of Cloud Computing to provide IT infrastructure during COVID-19***

The pandemic of COVID-19 has widely metamorphosed the operations of business. Major organizations are relying on cloud applications and cloud services has become a "new normal." A study by CommVault revealed that 93% of business leaders opined that they are moving some portions of their infrastructure to cloud services. The ineluctable importance of Cloud Computing during COVID-19 are flexibility, reduced operational costs and quicker deployment. Cloud Computing offers flexibility which is needed to adjust to fluctuating business environments. During these times of slow growth and low profits, companies have been able to remove storage spaces, applications and unwanted features, hence, paying only for the resources that has been used. Cloud Computing has helped several companies eliminate extreme expense of hardware, cost of IT resources, strengthened maintenance of internal systems of data and modernizations of IT infrastructures and automation of processes. Companies have been able to save substantial costs of capital and witness higher returns on investments. With the use of cloud computing, companies got the advantages of better deployment and launching of programs and applications seamlessly and faster. In fact, flexible,

cost-effective solutions and scalable have been the keys to thrive during a horrendous time of a global pandemic (Nguyen, 2020).

- *Benefits and use of Big Data Management and Machine Learning Techniques to provide IT infrastructure during COVID-19*

Amidst COVID-19 pandemic, big data analytics have played an instrumental role in tracking and reducing health disparities among patient populations. With the tools of big data analytics, providers have delivered the required care to the required patients at the required time. The clinics have used big data to navigate the initial phase of the pandemic which has given them essential information to treat patients (Marr, 2020). Surveillance infrastructure has been used to track contaminated people. This was the case in China, where thermal scanners were installed in train stations. This helped in detecting COVID-19 cases. The presence of cameras also helped the governments of all countries to spot if quarantine protocols were followed. Much like the "Aarogya Setu App" of India, China's "Close Contact Detector" app was also used to detect contamination.

In continents like Europe and America, where contamination rates were high and myriad people lost their lives during the initial outbreak of the pandemic, a mobile app to provide data in order to control the virus with an integrated strategy was being planned via the development of a mobile app by "Oxford University's Big Data Institute" along with the government officials. A similar app called "FluPhone" was developed in 2011, but it was not largely adopted. In USA, the government is planning along with technological behemoths like Facebook, Google and many others for using location data from the smartphone users of the country to track movements and understanding patterns. Besides, dashboards from WHO has been providing real-time statistics, which has been imperative to see the progress of contagion and to inform models about the extent to which the virus could invade. The dashboards pull data from across the world to reveal confirmed COVID-19 cases and deaths. This data is then used for creation of models and prediction of hotspots, thus, enabling decisions (Kent, 2020). Big data has provided an enormous amount of data to the scientists and doctors to frame informed decisions in order to combat the COVID-19 fight. In a nutshell, the benefits of Big Data has been seen in being used as an antecedent and potent tool for analyzing the transmission of COVID-19 virus, movement, monitoring of health and prevention of spread of COVID-19 (Godfried, 2020).

Outbreak analytics takes all the data which is available and then processes it through machine learning to create disease models. These models are a

representation of the predictions related to the peak contamination rates and outcomes. Machine Learning Tools (MLT) have been classified into 3 themes which are "Computational Epidemiology theme, Early Detection and Diagnosis theme and Disease Progression theme" (Syeda et al., 2020).

• *Modeling techniques and statistical projections that are used to predict the spread of the COVID-19 virus and decision making*

The disease of COVID-19 has affected more than 170 countries and the accelerating pace of cases and mortality has been quite high. In this light, forecasting techniques has been assisting to design strategies and productive decision-making. These techniques helps in assessing the past situations which will enable robust predictions about situations to occur in future. Forecasting techniques are playing a pivotal role in yielding accurate predictions. Besides, collection of data from various platforms also play an instrumental role in the process of forecasting. Forecasting the spread of COVID-19 disease can be done on the basis of parameters like impact of environmental factors, impact of quarantine, period of incubation, demographics, daily death counts, availability of medical facilities, mobility, strategic policies, awareness about COVID-19 and many more. Mishra et al. (2020) in their study analyzed certain prediction algorithm and metrics of model accuracy. The various prediction models considered in their study include ARIMA, SARIMA, GARCH, Prophet, and LSTM. Model accuracy metrics were used to make a comparison between the fitness and performance of prediction of the ARIMA, SARIMA and Prophet models. These criteria are the "Schwarz Criterion" (SC), "Akaike Information Criterion" (AIC), "Mean Absolute Error" (MEA), "Mean Absolute Percentage Error" (MAPE), "Root Mean Square Error" (RMSE) and "Theil Inequality Coefficient" (Theil's U). Their study was based on India which should guide future researches and their findings would be of extreme importance to the users of models and statistical techniques.

• *Effects of COVID-19 on virtual healthcare with usage of IoT technology*

The jolts triggered by the pandemic sent shockwaves all across the world which ultimately resulted in the healthcare services being conducted virtually. Prior to this, healthcare sector of India has been modernizing at a breakneck pace which had carried out medical activities with accuracy. After the outbreak of Coronavirus, technology has been hailed as a talisman and a much needed tonic to help the world cope up with myriad challenges that existed. It has been noticed that medical professionals have been adopting new methods of treating patients, simultaneously avoiding in-person treatments, unless absolutely vital (Mehta, 2021).

Several companies have come to the forefront to assist society during these testing times. One such company is Loterra, which is a marketplace which helps businesses to find appropriate IoT service providers. It also extended its services by partnering with several other companies to provide medical devices and products. A common example would be the monitoring of a patient's temperature to detect whether he has been affected or not. Wearable IoT devices such as smartwatches has been providing required information about a patient's heart rate, blood oxygen level, blood sugar level, etc. The integration of IoT gadgets with smart-sensors and algorithms in the milieu of medicine, which are connected to an application by cloud and other computing devices, has really been extremely helpful in fighting this ongoing pandemic of COVID-19 (D'mello, 2021). Some of the significant services offered by IoT in healthcare include telemedicine, robotic sanitization, contact tracing and privatization and protection of data. As per the Vodafone IoT Spotlight Report (2020), 84% of businesses claimed that IoT was essential for their survival during COVID-19. IoT has also been used in cold supply chain to monitor the vials of COVID-19 vaccines in real time and identify the loopholes in the logistics.

Escalation in the use of smartphones, smart bracelets and patches has been witnessed which has helped in the detection, regulation and management of COVID-19 cases and symptoms. "Corona-combat" drones equipped with thermal scanner, disinfectant tanks, spotlights, night vision cameras and durable medical boxes were installed in New Delhi, India with the intention of curbing the spread of the virus. The drones approached people of New Delhi in their respective balconies to check their temperatures and even provided medical supplies. The potential of robotics has been prodigiously hailed during COVID-19. A Japanese COVID-19 testing robot was established that has conducted around 2000 independent PCR tests per day without the help of clinicians, except for collecting the samples. This has large scale implications as it would increase the global COVID-19 testing capacity. In hospitals, nonsurgical robots have been used to disinfect reusable products such as medical equipment, PPE, and hospital beds. Besides, IoT sensors have also been installed in office spaces for monitoring and reporting on air-quality and detection of COVID-19 particles in the air. The high traffic areas also witnessed the installation of IoT sensors and thermal detectors for identification of people with high temperatures. The role played by IoT during COVID-19 in the milieu of virtual healthcare has been

impeccable and augurs outstandingly well for the coming days in the tussle against the deadly disease (Wessing, 2021).

2. Conclusion

The present endeavor is a case-based study which highlights and describes the impact of COVID-19 pandemic on healthcare and IT sectors. Although most of the study has been developed on the basis of existing literatures in the form of available e-resources, blogs, posts, e-newspapers, etc., the study is a pivotal find in the light of the given situation dealing with the bedlam triggered by COVID-19, the challenges faced by various sectors, and the myriad innovations and changes that have been witnessed. In a nutshell, both the disadvantages and advantages have been highlighted. The current ongoing pandemic of COVID-19 novel Coronavirus is an unprecedented global crisis which is enforcing major changes in almost all sectors. Although the challenges poised at the face of each and every sector have been immense, the focus especially gets on healthcare and IT sector. Healthcare sector is now the main sector of any country that is being hailed as the talisman and answer to the global pandemic, while the IT sector is the antecedent and the nifty driving force for any changes, particularly the bewildering metamorphosis of the eye-twitching percolations of technological innovations in the landscape of healthcare sector. Truth to be told, the complete evisceration of the COVID-19 pandemic will not happen overnight and is to take some time. Nevertheless, many hotshots and stakeholders have opined that the emergence of the pandemic was a blessing in disguise especially for the healthcare and IT sectors as major weaklings of such sectors has been exposed and has given their leaders much food for thought. It is during these head-scratching challenges, that the sectors has been able to step up with the best of agile solutions which is slowly but steadily making giant strides in proving vital in the context of the present times. In fact, most of the changes are here to stay for the long haul even in the postpandemic era.

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