Digital Transformation Acceleration in Health Sector during COVID-19: Drivers and Consequences

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Abstract **Purpose:** This study investigates whether the COVID-19 pandemic has a positive impact on accelerating digital transformation in the healthcare sector. Culture, technologies used, and the organization's business process had to be adapted to the situation. And these three factors are also considered the main pillar of the digital transformation and for sure these factors will contribute to the expedite of DT with the effect of the pandemic. It is also important to highlight one outcome of that acceleration in all the parties/players benefiting from health including patients' healthcare providers Healthcare industry HCI. The post-COVID situation can be also anticipated based on the input from the literature review and the research survey. Since most business experts are anticipating that life will not go back to the previous normal situation. And this anticipation is certainly based on studies published in recent years. **Aim and objectives:** The aim of the study is to find out the effect of COVID -19 as a moderator on digital transformation (DT) in healthcare and its drivers. And to depict how the accelerated digital transformation affects the patients and healthcare professionals. The study has managed to further check if the healthcare system and industry are improved and promoted with new products and markets, and investors who can build technological solutions for better healthcare startups or the healthcare industry. More attention is given to the international communities and their interest in the application of digital transformation in healthcare, and some examples are given of the current application. **Hypotheses:** This study has managed to examine the main pillars as drivers of DT in terms of culture, technology, and process and the impact on the Healthcare system's main players. The influence of digital transformation and its magnification has also been presented in the current study and has been studied and analyzed in depth. Direct and indirect hypotheses were made and analyzed. The direct hypotheses were built based on Patient and HC provider Culture and its effect on Accelerated Digital Transformation, Technology and Innovation and its effect on Accelerated Digital Transformation, HC Business Process and its effect on Accelerated Digital Transformation, H4: Accelerated Digital Transformation impact on Better Patient experience, Accelerated Digital Transformation impact on having more HC Provider Facilities, and Accelerated Digital Transformation and its impact on promoted HCI. COVID-19 effects were presented based on its moderator effect on Accelerated Digital Transformation with Patient and HC provider Culture, Technology and Innovation, and HC Business Process. Indirect Hypotheses were established based on the proposed module during the analysis stage. **Design/methodology/approach:** The study proposes a research model that was established based on comprehensive research and a fully constructive literature review that simulates the variables and the relationships among all these variables. Based on this model research hypothesis will be built that will be further investigated by a survey that considered primary data and analysis. The target population are mainly healthcare provider and patient with experience with any new technology related to DT. WHO and the Middle East and the North Africa Association of Health Informatics can be also good communities to explore and target in the survey since they are very familiar with the topic and international and regional health governing bodies. The sample size was calculated, and the study estimated that for a population size of more than 700K, we need to use a sample of around 380 participants with a Confidence Level (95%) and Margin of Error (5%). **Main results:** The results of the data analysis revealed that respondents showed that most of the drivers' variables had a significant effect on digital transformation. However, the unexpected non-significant effect appeared for the healthcare providers and patient culture. Digital Transformation had a great impact on the healthcare bodies and their digital experience including the healthcare industry. COVID-19 made a great impact on the DT variable and most of the drivers. Indirect relationships were also investigated in the analysis and presented in the study and the results showed that the direct effects were proven, and a highly significant effect was shown of the direct effect, it is also proven that the moderator effect from covid-19 is not supported.

Keywords: digital health, healthcare, COVID-19 pandemic, digital transformation, DHCM, IoMT

1. Introduction

1.1. COVID-19 and Digital Health

At the end of 2019, a novel coronavirus disease (named later COVID-19) broke out suddenly and spread rapidly and become a global pandemic. Globally, as of 13th of May 2022, there have been 517,648,631 confirmed cases of COVID-19, including 6,261,708 deaths, reported to the World Health Organization [14].

This pandemic had a great impact on most business sectors and industries. Having said that, COVID-19 had a great negative impact on most of the business sectors, however, it had also some positive impact in some sectors when it is considered an opportunity. Some businesses had a business continuity plan (BCP) and had the required digital infrastructure that helped them to respond positively at the time of the pandemic. As an example, in the telecommunication business Zoom (the videoconferencing compact) skyrocketed to $70 billion in June 2020 (Correspondent, R.N.W., 2020), Amazon and Walmart hired a combined 250,000 workers to keep up with the increase in demand and built massive infrastructure to deliver online [15]. It is not by accident that mega-firms like Alibaba, Amazon, Netflix, or Zoom are considered "winners" from the lockdowns [16]. Customers found a lot of varieties in different means compared with the regular shopping modalities (physical ways of dealing with business and daily needs). It is clear that COVID-19 has been economically destructive in several ways in the given examples, governments block cities to control the spread of the pandemic that making a business around the world is significantly disrupted as both imports and exports are deferred/blocked. This led to a huge reduction in demand due to the lockdown. Moreover, Production capacities have been delayed/reduced while fixed costs are still running in most of the big businesses leading to serious cash flow. As a result, the damage caused by the outbreak is anticipated to be long-lasting and have a big effect on global economic growth.

This pandemic is considered the first in human history in which innovative digital technologies and social media are being used on an unprecedented scale to keep people connected, safe and productive while being physically and socially apart.

The Healthcare sector is one of the business industries that have been digitally enhanced/strengthen during that pandemic in the area 0f surveillance, prevention & promotion, diagnostics, therapeutics, Follow up, patient Communication, and HC Community engagement.

These areas facilitate the effective identification, reporting, and analysis of cases and contacts; early search for and detection of cases; and identification and monitoring of at-risk populations, and contacts. Control is strengthened through platforms/applications for follow-up and monitoring of patients, contacts, quarantine, and social isolation. These systems, in turn, enable mass dissemination of information on preventive measures to all of society. All these areas are supported by a lot of inventions that covered/accelerated all the digital transformation processes [17].

1.2. Research Aims and Objectives

The purpose of this study is to investigate the effect of COVID-19 on the digital transformation (DT) in the healthcare sector with an indirect effect on the DT drivers. And show how digital transformation will affect the patients and Health workers with all the provided digital transformation magnification tools and magnification. Moreover, the study will check if the healthcare system and industry will be improved and promoted with new products and markets, and investors which may build a technology solution for better healthcare startups or the healthcare industry.

In the end, it is important to anticipate how the situation after the pandemic will be. Since it is expected that life will not go back to the previous situation.

It is planned to propose a research model that will simulate the variables and the relationships among all these variables extracted from the study's theoretical background and literature review. Based on the model the research hypothesis will be built that will be further investigated even through a life survey or analysis of a given data related to the subject.

1.3. Research Gap

Digital changes and interference were going on too slowly to be noticed by the patient and the healthcare providers. However, the impact of COVID-19 as ongoing disruptive technology adoption is evolving the Markets rapidly. There are a very limited number of studies that tackled this phenomenon, especially during COVID-19. In some cases, the current study relied on information from the private sectors and healthcare industry to have a better view of the real situation of the HC technology product in the market since there won't be enough imperial studies or resources about the topic under study. This study needs to prove that the pandemic has a direct effect on the relationship between digital transformation and its pillars or drivers. Moreover, no studies showed the big picture of the cause in terms of drivers and the effect in terms of the impact on DT and especially during the COVID-19 era. In the business sectors, new products and markets were introduced because of the revelation of health-related technology which needs to be covered in the current study through historical studies. Adding to this, a lot of studies ignored the digital transformation interest by the international community related to health sectors that are representing the main international regulators and governing bodies.

1.4. Research Questions

This research provides many questions that are summarized as follows:

1. What is the impact of Patient and HC provider digital Culture in DT?
2. What is the impact of technology and innovation in DT?
3. What is the impact of HC digital business processes in DT?

4. What is the COVID-19 pandemic impact on Patient and HC providers' digital Culture and digital transformation relation?
5. What is the COVID-19 pandemic impact on Digital Technology and digital transformation relation?
6. What is the COVID-19 pandemic impact on HC digital business processes and digital transformation relation?
7. What is the impact of the DT on the patient's digital experience?
8. What is the impact of the DT on the benefits and facility for the HC provider?
9. What is the impact of DT in the healthcare industry in terms of Strategy, new market, and product, and the HC decision-makers?

Moreover, it will be a good chance to check if the effect of the pandemic on the Health digital transformation will be sustained and promoted. So the last research question will be

10. What will be the situation after the pandemic and the future effect of DT in health-related areas?

2. Digital Transformation DT

Digital Transformation (DT) was started early enough before the pandemic and there was an incredible boost to technologies and processes that enable customers to do things remotely. Examples of such activities are Universal broadband internet, mobile, remote payment, workable e-government services, and others. During 2019 and with the starting of the pandemic the businesses that were already operating online are bound to benefit from a lasting competitive advantage. "Digital transformation is the integration of digital technology into all areas of a business, fundamentally changing how you operate and deliver value to customers. It's also a cultural change that requires organizations to continually challenge the status quo, experiment, and get comfortable with failure." [18].

"Digital transformation marks a radical rethinking of how an organization uses technology, people, and processes to fundamentally change business performance." [19]. Based on this definition it may be considered that people culture, technology, and organizations that should continually challenge its process may consider the major driver of the DT in almost all business sectors.

On the other hand, Kwon, E. and Park, M. [1] defined DT as the following table that shows the DT perspective from different sources that are considered the best technology leaders' firms in the world.

3. Main Pillars and Drivers of Digital Transformation

To have DT implemented Culture was supposed to be reshaped and adapted to the new approach. Technologies were also supposed to be ready to open the doors for the DT and act as a driver and make sure that enough disruption, innovation, and Technology enablers are available for the required needs. The business processes also had to be adapted to the needs of the customers and reformed for the disruptions of the innovation [20]. Stanfield, N. [20] referred to findings from McKinsey & Company that revealed the deploying of multiple technologies is a key to a successful digital transformation, with the transformation that is wide in scope being more successful than ones that are only focusing on one or two technologies. Stanfield, N. [20] defined Digital Transformation as "DT is the intelligent way businesses are meeting expectations of changing the business landscape by creating new – or modifying existing Process, culture and customer/client/stakeholder experiences". The study is complementing this definition and confirm that DT is affecting every industry to have a successful forward-thinking, and innovative business, business owners must take it in their pace to digest the modern technological landscape in which upcoming technologies can transform their business for the better.

4. International Efforts toward Digital Health

mHealth and eHealth - can be considered as an application of digital transformation that started before the pandemic. These two applications were greatly expanded during COVID -19. A recent paper by Dr. Mandil, A. WHO (2021) illustrates the importance of these two global approaches to the DT as a global/cross-country application of DT during COVID -19.

4.1. eHealth

Health is a relatively recent health care practice supported by electronic processes and communications, developed at least in 1999. The term eHealth is used variously to encompass not only "Internet medicine" as it was conceived at the time, but also "virtually anything related to computers and medicine." The advantage is the ability to find useful health resources on the Internet and to search and evaluate health information on the Internet and use health information to solve health problems.

Table 1. Digital health and COVID-19 response Source: WHO (2020)

Bahrain: BeAware Bahrain **Djibouti**: DHIS-2 **Egypt**: Seha-Masr, Ekhshef online, AVHospital **Islamic Republic of Iran**: salmat.gov.ir **Jordan**: Edraak, Aman, Sehtak, Crader, Bader	**Kuwait**: Shlonik (5 languages) **Lebanon**: Century Tech **Morocco**: Wiqayetna **Oman**: Tarassud, Bahhar (Sailor), e-Jaza **Pakistan**: Open Smart Register Platform **Palestine**: Weqaya (prevention), DHIS-2	**Saudi Arabia**: Sehha, Sehhaty, Wasfaty, Mawid, Tetamman, Tawakalna, Tabaud **Somalia**: DHIS-2 solar-powered oxygen **Sudan**: 4949-NCD health services	**Qatar**: Ehteraz, ECHO-360, mental health helpline **Tunisia**: Ehme (Protect), P-Guard Robot **United Arab Emirates**: Alhosn, Manassa-eldoctor-eleftrady, StayHome, COVID19-DXB app, robots, smart helmet technology, etc. **UNRWA**: Your health with UNRWA

Some other applications have been developed to respond to the pandemic in several Middle Eastern countries, and these applications will certainly be linked to a big data repository and may use AI validation for quality data. Examples of these applications

4.2. mHealth

mHealth is an abbreviation for mobile health. The term is mostly used for using mobile communication devices, such as mobile phones, tablet computers and personal digital assistants (PDAs), and wearable devices such as smartwatches, for health services, information, and data collection. Its apps are designed to support diagnostic procedures, aid physician decision-making for treatments, and advance disease-related education for physicians and people under treatment. mHealth encompasses the use of mobile telecommunication and multimedia technologies as they are integrated within increasingly mobile and wireless healthcare delivery systems. The field broadly encompasses the use of mobile telecommunication and multimedia technologies in healthcare delivery. The term mHealth was invented by Robert Istepanian for use of "emerging mobile communications and network technologies for healthcare". According to the International Telecommunication Union there are now close to 5 billion mobile phone subscriptions in the world, with over 85% of the world's population now covered by a commercial wireless signal. The penetration of mobile phone networks in many low- and middle-income countries surpasses other infrastructure such as paved roads and electricity, and dwarfs fixed Internet deployment. Some countries established their own mobile application to support a certain disease or outbreak. Examples from our region are Egypt, Sudan, and Tunisia which had the following APPs developed to strengthen their health sector capabilities.

Egypt	Sudan	Tunisia
mDiabetes	mDiabetes	mCessation
mTB-Tobacco	mCervicalCancer	mDiabetes
	• mBreastCancer	• mHajj

5. How has the COVID-19 Pandemic Affected Digital Transformation Drivers and Main Pillars?

The biggest driver for change today in businesses is digital transformation. According to the Harvard Business School study [21] researchers interviewed 344 senior business and technology leaders via phone, asking them 74 questions about the technologies they have deployed, firms that embrace digital tech transformations had an average of 55% growth margins over three years. From 2017 onwards, there have been many innovative technological trends that have shaped how people view the digital world today.

"We've seen the COVID crisis rapidly re-shape both the "what" and the "how" of companies' digital transformation agendas" (Korn Ferry's Swift, 2021).

A global survey question results Published by Statista. [22] that were questioning "Has the COVID-19 pandemic sped up digital transformation in your organization?". As this global survey of 2,569 respondents showed that 97% of respondents state that the outbreak of the COVID-19 pandemic accelerated the digital transformation processes in their firms. Specifically, 68% reported that digital transformation sped up a great deal in their firms. As the pandemic emerged many businesses organized for employees to work from home, and digitization processes accelerated greatly to keep up with this sudden demand for remote work.

As per Stanfield, N. [20] businesses that were unwilling to cope with digital technology saw just 37% margin growth during the same period. During the COVID-19 era. Clients found a lot of varieties in different means compared with the regular life needs modalities. However, during the peak of the pandemic, it was a must to highlight the importance of having both an online and offline presence "online to offline (O2O)". Online-to-offline (O2O) commerce is a business strategy that draws potential clients from online channels to make purchases in physical stores. Online-to-offline (O2O) commerce identifies clients in the online space, such as through emails and Internet advertising, and then uses a variety of tools and approaches to entice the customers to leave the online space". A study conducted by Investopedia [23] showed that the pandemic crisis accelerated this phenomenon because it both forced and encouraged the customers to digital solutions. The study could go as far as to say that, for a little while, a lot of activity had to take place remotely like teleportation supplanted transportation, most executive committee meetings, board meetings, team meetings, brainstorming exercises, and other forms of personal or social interaction.

6. DT Impact on HC Main Players

Impact of Digital transformation effect on patient digital experience

Smart healthcare facilities that improve patient outcomes. Metrikus-co [24] has focused on specific uses of IoMT that can help to change healthcare as currently known. They are also required to focus on how IoMT can make healthcare facilities smarter, safer, and more efficient. These solutions came in the shape of indoor air quality monitoring, Occupancy monitoring, Access control, Resource tracing, Smart cleaning, and Fridge and freezer monitoring Health systems and equipment increasingly connect over wired and/or cloud networks. The correlation between the two means describes the extent to which systems and devices can exchange and interpret shared data. It also allows for the authorized use of data and the exchange of medical data to facilitate decision-supported patient-centric care and reduce medical errors.

Interoperability in healthcare is extremely complex and relies on being able to establish connectivity and communication between devices and IT systems, and between data and workflows while allowing secure and transparent data exchange through consensus standards and protocols. Metrikus-co (2021) lists the outcome that patients and healthcare providers will gain when applying DT technology to the HCI process (Improve Patient outcome.).

HC, IT news (2020) showed that the UAE Ministry of Health and Prevention has established virtual clinics that

provide a range of outpatient services: from cardiology and pediatrics to physiotherapy and mental health services. By May 2021, the clinics had reportedly cared for more than 15,000 patients, in line with government directives to use smart solutions in the fight against COVID-19. Virtual hospitals have been incredibly useful in the context of the pandemic, and they have the potential to change the way care is delivered in the long term. HC Wearable devices (better digital experience for the patients).

HCI has been slow to adopt new technologies, largely due to their proliferation and highly complex systems. However, with the advent of the Internet of Things (IoT), wearable technology, and healthcare-connected devices, patients are empowered to take charge of their health and act accordingly. Healthcare providers are no longer the custodians of patient data but can positively influence patients to improve their engagement and health outcomes. It is worth highlighting that digital healthcare promotes overall quality of care, even when a patient lives hundreds of miles away from their doctor.

The World Economic Forum [25], has stated that "digital therapeutics can be defined as any intervention that is delivered digitally and has a therapeutic effect on a patient. They can be used to treat disease in a similar way to drugs or surgery." They also explained that the old way of communicating and collecting information about patients in the form of paper letters, medical records, prescriptions and educational brochures is outdated. Today, we can send emails, enter information into electronic databases, and access electronic medication charts. In a recent study, Kerfoot et al. [2] examined a team-based online game delivered through an app to provide diabetes self-management education. Participants who received the app in this study had significant and sustained improvements in their diabetes as measured by their HbA1c (blood glucose level). Diabetes is a good example: people with diabetes need to manage their disease to reduce their risk. App-based games of this type hold promise for improving chronic disease outcomes on a large scale. New electronic devices are being used by people of all ages to track their activity, measure their sleep, and record their diet. This information provides individuals and their therapists with immediate and accurate feedback so that adjustments can be made as needed. The recorded information can also be combined into large data sets to identify patterns over time and provide information for future treatments. Lee, S.M. and Lee, D. [3] conducted an empirical study examining the effects of internal and external factors on actual user behavior, health improvement expectation, and intention to continuously use wearable health devices.

Based on data collected from 288 users of wearable health devices/apps, the study found that internal and external factors have a positive impact on actual user behavior and that the expectation of health improvement and intention of continuous use of wearable health devices can be promoted by actual user behavior.

7. COVID-19 Effect on Patient and Health Care Provider Culture

The Health Foundation in the UK (2020) studied the patient-level data analysis of the impact of COVID-19 on primary care activity in England and provided detailed info and raw data about the healthcare providers and their mode of communication with patients in late 2018 and after the pandemic until June 2020. This analysis is based on a sample of 500,000 patients. The patient histories, diagnoses, and consultations allow for a more detailed understanding of primary care than is publicly available. The data is provided by patients and collected by the national health system NHS as part of their care and support.

The article used the patient-level primary care data set of the Clinical Practice Research Datalink (CPRD) to explore primary care activity and outcomes from a subset of practices. Unlike the high-level national health system NHS digital appointment data, this patient-level data allows matching consultations to patients by age, sex, geographical region, ethnicity, and whether they have been diagnosed with non-communicable diseases (NCDs). The data provide the most detailed view that can be accessed of the changes that the COVID-19 pandemic and accompanying lockdown have brought about. This study proved based on the information gathered from the health sectors in England that the face-to-face f2f meeting with the healthcare provider decreased during the lockdown and the non-f2f (remote) consultation increased. This is considered a big proof of changes regarding physical against virtual presents of the patient culture. As an example, based on a study conducted [26] on "Fear from COVID-19 and technology adoption: the impact of Google Meet during Coronavirus pandemic" that has used TAM model to show that the external variables related the student emotion and the technology adaption during COVID-19 era and the effect on the "perceived usefulness and ease of use" of any digital product. Having said that "perceived usefulness and ease of use" of technology can be very important to adapt the culture of the HC providers and patients in the health sector industry. Since the attitude and behavior of the HC providers and the patients will be changed by some external factors during the pandemic, this means culture and technology will be affected because of COVID-19.

8. COVID-19 Effect on Technologies

The previous example can be can also affect the variables under the Technology and innovation area. Since perceived usefulness and ease of use variables can be considered one of the main characteristics of technology and innovation. Google meeting (GM) as a technology can be considered as one of the main DT Magnification means in social communication. The digital revolution has transformed many aspects of life. Based on Mobile market analysis (2019), 67% of the global population had subscribed to mobile devices, of which 65% were smartphones-with the fastest growth. In 2019 only, 204 billion apps were downloaded [27], and Kemp, S. [28] showed that 3.8 billion people actively used social media [28]. With a rate of 26% increase in the health and fitness sector. European Healthcare report, for example, Deloitte [29] surveyed "Digital Transformation: Shaping the Future of European Healthcare" showed COVID-19 increased the adoption of digital technologies to support

the healthcare industry and the ways of HC workers that are working to a great extent according to 28.7% of the European organizations surveyed, and to some extent for 36.6% of them.

It is clearly shown that COVID-19 helped to increase the technology effect on the healthcare industry and consequently DT has been accelerated because of the big innovation in the technology and telecommunication sector. Later, the current study will deeply cover the magnification of the DT that should be considered one of the big technology disruptions during the pandemic.

9. COVID-19 Effect on HC Business Process

Fardeen [4] conducted an empirical study on the impact of COVID 19 on Businesses and has tried to investigate the difficulties faced by a business located in different countries including India. The study found that the businesses have faced a huge crisis with reduced operations and fewer profits compared to the previous year and most of the people lost their jobs. Rockhealth [5] who provided a trend analysis of the Digital health funding between 2011- 202 in the investment increased in digital health showed that the COVID-19 pandemic pushed digital health into high gear. As presented before in chapter 12, the first half of 2021 (H1) closed with 14.7B$ invested across 372 US digital health deals with a $39.6M average deal size. Fifty-nine percent of that funding came from 48 mega deals ($100M+). The year 2021 already exceeded 2020's overall funding record. Monthly funding in June 2021 ($3.1B) was almost three times more than that of June 2020 ($1.1B). This is considered an emerging reaction in the market to COVID-19 and the increase of investment in digital health was a must that affected the DT phenomenon.

"We're seeing an increase in round sizes, new investors, and the pace at which funding is happening in digital health. There's an acceleration of exits, as well as the emergence of combined companies that can address healthcare more broadly. It is exciting to see how quickly everything is happening this year." [30].

10. Anticipation of Post-Covid-19 World

Covid-19 has had a major impact on the digitization of healthcare, so it is expected that more healthcare providers will turn to digital technologies in the coming years. [31].

Harvard Business Review Analytic Services [32], an independent commercial research unit within the Harvard Business Review Group, conducted research and comparative analysis on key management challenges and emerging business opportunities and concluded that the impact of the pandemic on global businesses is likely to reverberate for years to come. COVID-19 has reshaped the business strategies of companies across industries and geographies.

New best practices are being developed by digital transformation researchers and practitioners. As executives decide how to drive modernization in the coming months, they should be ready to embrace new ideas.

Lisa Nagel's [33] study assesses the implications of the pandemic COVID -19 for the future. In order to assess the long-term consequences of the pandemic on the digitization of labor, research is needed that includes the macroeconomic consequences in their forecast. They used the source of income and the form of labor as a factor to test the future anticipation of the impact COVID. The study shows that the importance of traditional jobs as a secure source of income is decreasing, and the importance of digital jobs is increasing. It also highlights that there will be a slight increase in the future.

11. Main Hypothesis Based on the Historical Studies

From the literature review, the main pillars and drivers of DT are culture, technology, and process, based on the variables and research model identified in the study. The following hypothesis illustrates the relationship between DT and patient/HC provider culture, technology and innovation, and HC business process in the following hypothesis.

- H1: Patient and HC provider digital Cultures are affecting digital transformation
- H2: Digital technology and innovation are somehow affecting DT, through perceived usefulness and ease of use of digital devices and applications, disruptive innovation, and intelligent automation.
- H3: Digital transformation may be affected by the HC digital process in terms of investment in digital HC and business strategy
- H1a: Covid-19 positively and significantly influences Patient/HC provider digital culture that will appear as accelerated Digital Transformation Magnification.
- H2a: Covid-19 pushes the Technology and innovation and disrupts regular ways of HC player engagement, which should appear in the more utilization of digital health gadgets (IoT, IoMT, VR, RPA, and AI) that lead to Accelerated DT.
- H3a: Increasing HC business investments and reforming business strategy because of COVID-19 that appeared in the advanced Digital application is accelerating DT.

The benefits or the outcome of the Accelerated DT during the COVID time can be shown in the second phase of the model and this can be simulated on H4, H5 and H6.

- H4: DT will lead to a better patient digital experience and increase the patient/physician Engagement using better technology like (IoT, IoMT, VR, RPA, and AI) they will lead to promotion in Patient/HC provider digital culture
- H5: DT drivers provide more facilities to the HC providers in terms of increasing remote monitoring.
- H6: Accelerated DT managed to promote HCI in terms of introducing new products and markets, new policies and a better HC digital strategy.

All these hypotheses indicate that COVID -19 has a moderating effect on the acceleration of digital transformation in healthcare. It is assumed that covid-19 has a direct influence on the explained variables and acts as a moderator in the relationship between these variables and DT. COVID -19 will consequently accelerate the digital transformation in healthcare.

The more people believe in the increasing prevalence of DT due to the COVID -19 pandemic, the more likely they are to imagine working exclusively digitally in the future. And based on this, the seventh hypothesis may be

* H7: More likely Digital transformation effect will increase exclusively in the future even after COVID-19.

12. Proposed Research Model

Based on the literature review, it became clear that the key pillars/drivers of DT are culture, technology, and business processes in healthcare. For the healthcare environment, it can be seen that some parameters impact DT. COVID -19 has a modulating effect on the drivers on DT. COVID -19 has a modulating effect on the culture of key stakeholders (patients and healthcare providers) in terms of digital maturity and reluctance to have normal physical contact with the healthcare provider. Technology was also affected by the pandemic, as digital tools were desperately needed to respond to COVID. The key player's sense of the perceived usefulness and usability of digital applications and devices needed to be improved as quickly as possible to respond to the situation. On this basis, COVID -19 drove technology and helped accelerate DT. All hypotheses are provided to support the findings of LR.

COVID-19 had a significant impact on DT augmentation, which translated into 1) technology and innovations (IoT, AIoT, IoMT, VR, RPA, and AI). These are considered DT gadgets that are transforming digital life in the healthcare sector. 2) Telemedicine and Big Data handlers previously explained in the international interest in digital transformation. Examples given are mHelath and eHealth. 3) Digital infrastructure presented on the Internet as the main means of communication between the devices and the Big Data information repository.

13. Research Methodology

13.1. Participants

The target population is primarily health care providers and patients who have experience with new technologies related to DT. WHO and the Middle East and the North Africa Association of Health Informatics may also be good target populations for the survey, as they are international and regional health bodies very familiar with the topic. We can easily identify the sample of the population used by filtering out those who do not practice or use such HC-related technologies. There are no restrictions on age, location, and background or area of work. This will enrich the data collected through a published survey. A sample consisting of all individuals who have had experience with the COVID -19 health care system was drawn using the simple random sampling method. The survey will be conducted using an online survey whose responses will be based on the experiences and knowledge of COVID -19 health care providers, patients, and professionals.
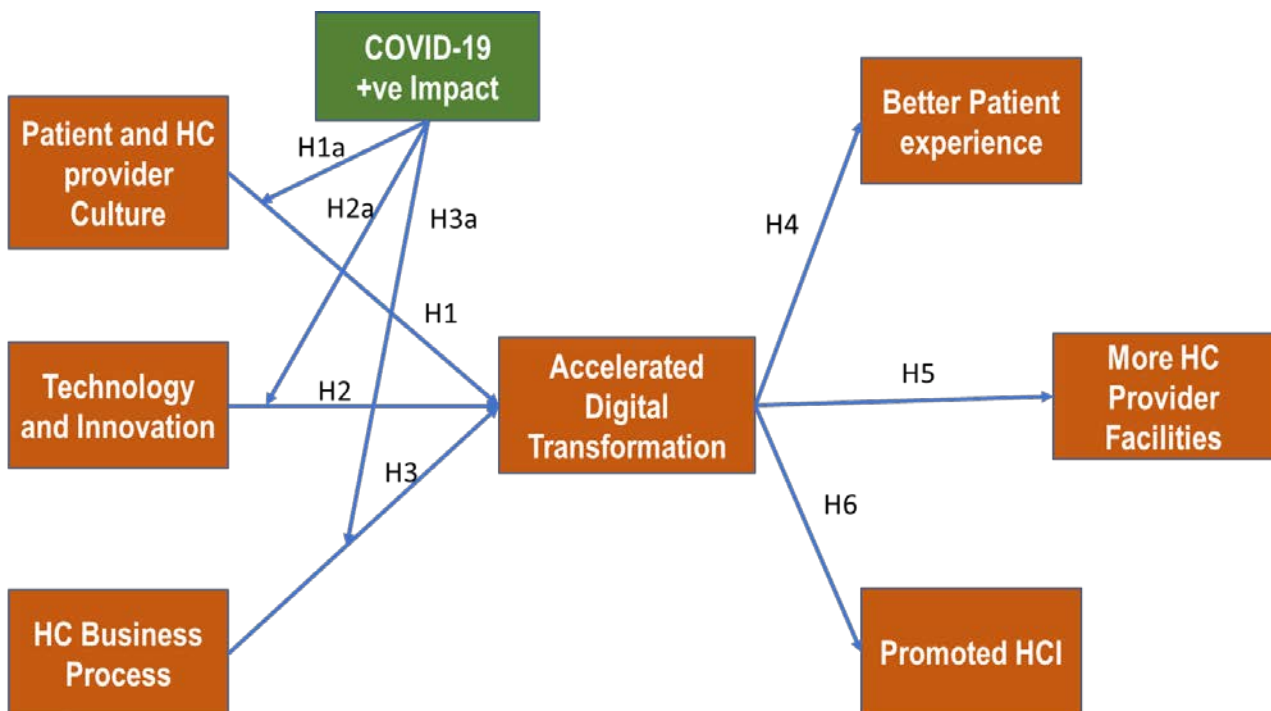

Figure 1. The research proposed theoretical model (Own design)

13.2. Method

The study questionnaire designed based on the sources provided, literature review, and historical studies, as well as the model and hypotheses created, will be used for this survey. The study will analyze the collected data using SPSS or Minitab to obtain the required statistical results to confirm or refute the proposed hypotheses.

According to Sekaran and Bougie [6], the term "population" refers to "the entire group of people, events, or things that the researcher wishes to study." The present survey could be conducted in some cases to ask the whole population, which is called a survey. In this study, it is not possible to survey the entire population of health care providers and patients due to cost and practical reasons, as it is not possible to identify all members of our target population. An appropriately selected sample can provide sufficient information (Hair et al. 2009) [39] to appreciate drawing inferences from samples to the whole population, because in the whole population "any difference or relationship, no matter how small, is true and does exist. Moreover, targeting the entire population eliminates the need for statistical inference" because targeting a sample has the advantages of lower cost, less effort, time efficiency for time-limited studies, and better response rates and higher accuracy.

13.3. Materials

The steps of sample design define surveys as a "research technique in which information is collected from a sample of people using a questionnaire; a method of data collection based on communication with a representative sample of people" [34] (p. 146). Survey-based research "provides a quantitative or numerical description of trends, attitudes, or opinions of a population by studying a sample of that population" [35]. The survey strategy has been used to collect data to test research hypotheses. It is relatively inexpensive and best suited for collecting data on a relatively large number of variables from many individuals. (Hair et al. 2000) [40] s cited in Waidi, A. A. [36], stated that one of the main advantages of surveys is that "they collect quantitative data ripe for advanced statistical analysis patterns" and allow researchers to "identify large and small differences within data structures."

13.4. Variables and Dimensions

Based on the illustrated literature review built on the available recent historical studies including their conclusions and the factors they identified that control DT, the following independent variables were identified.

13.4.1. Independent Variables

Based on the main pillar (culture, technology, and organization) and related studies on LR, the following list of variables was created. Considering that the healthcare industry is different from all other businesses, the organization can be represented as a healthcare industry process. Bumann, Jimmy & Peter, Marc [7] reviewed 18 validated digital maturity models and frameworks that identify various indicators to consider for a DT strategy.

In a comparative analysis of over 100 indicators described, the most frequently cited indicators were strategy, organization, culture, technology, customer, and people (employees). The six identified dimensions/action areas guide the companies' processes to successfully shape the digital transformation. Technology is the means of DT and user culture is the driver of this technology, which can be influenced by the availability and ease of use of the new technology. Strategy and financing activities are one of the most important pillars of these drivers.

- Patient and HC provider Culture
  - Patient and health provider digital maturity.
  - Physical against virtual presents.
  - Perceived usefulness and ease of use. *(This dimension can be also measured under Technology)*
- Technology and Innovation
  - Disruption, innovation, and technology enabler.
  - Applications, Platforms Architecture.
  - Intelligent automation.
- HC Business Process
  - HC sector business strategy
  - The agility of HC change management and org structure.
  - Digital HC investment (Financial optimization)

13.4.2. Mediator Variables

The magnification of digital transformation was clearly detailed in the literature review. IoT, IoMT, VR, RPA and AI are considered as the main indicators of acceleration and magnification of DT. Big Data and the enlargement of digital infrastructure mean connections between all technologies, especially IoMT and wearable devices. A new technology now spreading in medical technology is AIoT, which is seen as a fusion of AI and IoT. It is expected that this accelerated innovation will soon moderate the scaling up of DT.

- Accelerated Digital Transformation Magnification
  - Technology (IoT, IoMT, AIoT, VR, RPA, and AI)
  - Data Handler of telemedicine and big data
  - Digital infrastructure
  - Advanced Digital Application and surveillance

13.5. Depended Variable

The implications of DT will affect the main player in this game. Patients should reap the rewards of new technology and better communication tools, and a positive impact on their wallets would be a good outcome of the DT. Healthcare providers should benefit from the impact of DT. Better facilities and better quality of health care are the goals that health care providers should strive for a better future. Protection during the pandemic is a major benefit to healthcare providers, and this can be achieved through better remote monitoring and diagnosis. To overcome the challenges of new technology, HCI should respond to the new technology (products and services) with appropriate regulatory and policy strategy which can be achieved by using the available new technology/data analytics. This will lead to better decision-making in the healthcare sector.

- Patient digital experience
  - Increased patient/physician engagement.

- ○ Mobility, cost, and time reduction.
- ○ Better patient digital culture.
- ○ Smart wearables analysis.
- • HC Provider Digital Facilities
- ○ Automatic notification.
- ○ Remote monitoring and diagnoses.
- ○ Better HC provider digital culture.
- ○ Improve the quality of HC providers.
- • HC Industry
- ○ New products and markets.
- ○ New regulations and Policies.
- ○ Better Health org culture.
- ○ Improve HC strategy.
- ○ Support decision-makers with reliable and quality information and analyses.

13.6. Moderating Variable

Since the research considered COVID-19 as the main reason that indirectly affects the acceleration of the DT through the mentioned independent variables.
- ○ COVID-19 positive effect/impact

14. Statistical Analysis Results (Findings)

14.1. Path Coefficients

Path coefficients refer to estimates of the relationships among constructs in the model [8]. These coefficients range from +1 to -1, with +1 indicating a strong positive relationship, 0 indicating a weak or nonexistent relationship, and -1 indicating a strong negative relationship [9]. When evaluating the PLS path, studies should report the path coefficients in addition to the significance level, t-value, and p-value [10]. Hypothesis testing was conducted to understand the sign, magnitude, and statistical significance of the estimated path coefficients between constructs. Higher path coefficients indicate stronger effects between the predictor and the predicted variables.

The significance of the supposed relationships has been established by measuring the significance of the *p*-values for each path with threshold $p < 0.05$, $p < 0.01$, $p < 0.001$ be

used to assess the significance of the path coefficient estimations [11,12]. Later, the inferences have been drawn for all hypotheses based on the significance of *p*-values at the above-mentioned conventional levels. The *p*-values and inference of hypotheses, as well as the confidence level for each estimate, are shown in Table 2. The results of hypothesis testing in Table 2 showed that Technology and Innovation construct yielded a significant direct positive effect on Accelerated Digital Transformation since $(\beta = 0.265, t = 4.518, P < 0.001, 95\%\ CI$ for $\beta = [0.157, 0.398])$, consequently, the second hypothesis is confirmed. Also, HC Business Process yielded a significant direct positive effect on accelerated digital transformation since $(\beta = 0.151, t = 2.284, P < 0.05, 95\%\ CI$ for $\beta = [0.019, 0.272])$, consequently, the third hypothesis is confirmed. Moreover, accelerated digital transformation has significant direct positive effect on better patient experience $(\beta = 0.468, P < 0.001)$, more HC provider facilities $(\beta = 0.31, P < 0.001)$, and promoted HCI $(\beta = 0.344, P < 0.001)$, as a results hypothesis from four to six are supported. Furthermore, COVID-19 construct has significant direct positive effect on accelerated digital transformation $(\beta = 0.362, P < 0.001)$, patient and HC provider culture $(\beta = 0.374, P < 0.001)$, technology and innovation $(\beta = 0.332, P < 0.001)$, and HC business process $(\beta = 0.501, P < 0.001)$, as a results hypothesis from seven to ten are supported.

14.2. Moderation Analysis

After evaluating the relationships among the variables in the model, the next step is to evaluate the moderating effect of the moderator variable "COVID -19". Baron and Kenny [13] defined moderator as a variable that affects the direction and/or strength of the relationship between an exogenous variable and an endogenous variable. When a moderator is incorporated into a path model, an interaction term must be created to analyze the influence of the moderator. The interaction term is created by multiplying each indicator of the exogenous construct by each indicator of the moderator to create the product indicators. This approach is used in this research. Performing the required analyzes produced the results shown in Figure 2 – Figure 4.

Table 2. Results of Hypothesis testing (Direct Effect)

Path	B	t-value	P-value	95% CL for B		Remark
				LL	UL	
H1: Patient and HC provider Culture -> Accelerated Digital Transformation	0.035	0.616	0.538[NS]	-0.076	0.138	Not Supported
H2: Technology and Innovation -> Accelerated Digital Transformation	0.265	4.518	0.000[***]	0.157	0.398	Supported
H3: HC Business Process -> Accelerated Digital Transformation	0.151	2.284	0.023[*]	0.019	0.272	Supported
H4: Accelerated Digital Transformation -> Better Patient experience	0.468	6.304	0.000[***]	0.31	0.594	Supported
H5: Accelerated Digital Transformation -> More HC Provider Facilities	0.31	3.879	0.000[***]	0.14	0.454	Supported
H6: Accelerated Digital Transformation -> Promoted HCI	0.344	4.495	0.000[***]	0.18	0.468	Supported
H8: COVID-19 -> Accelerated Digital Transformation	0.362	4.229	0.000[***]	0.198	0.53	Supported
H1d: COVID-19 -> Patient and HC provider Culture	0.374	6.325	0.000[***]	0.239	0.477	Supported
H2d: COVID-19 -> Technology and Innovation	0.332	5.015	0.000[***]	0.194	0.449	Supported
H3d: COVID-19 -> HC Business Process	0.501	5.895	0.000[***]	0.309	0.639	Supported

[***]$P < 0.001$; [**]$P < 0.01$; [*]$P < 0.05$; [NS] Not Significant; LL= Lower Limit; UL= Upper Limit; CI= Confidence Interval, H1d, H2d, and H3d refers to direct effect.
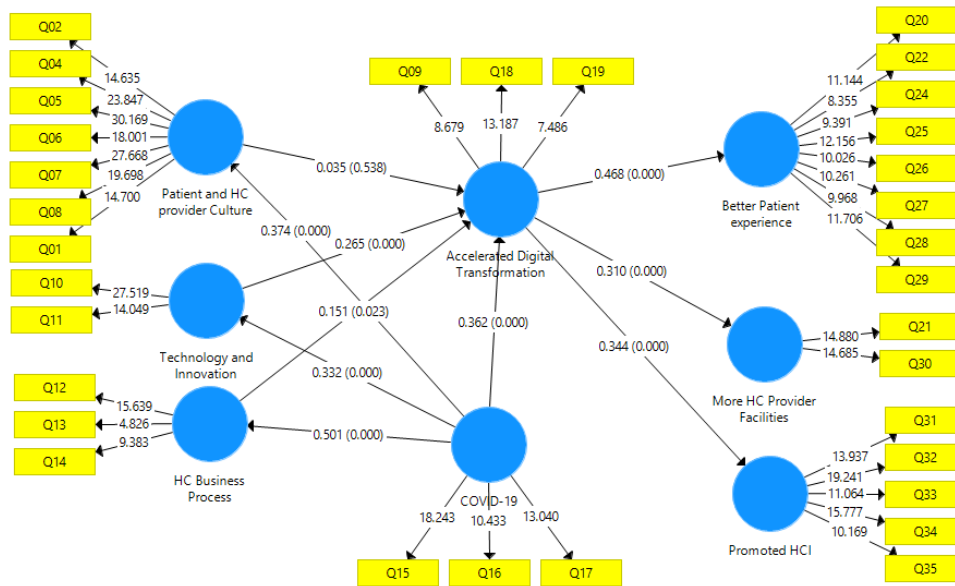
Figure 2. Structural model (Path coefficients and P-values)

Table 3. Mediation analysis (Indirect Effect)

| Path	B	t-value	P-values	95% for B		Remark
				LL	UL	
H11: Patient and HC provider Culture -> Accelerated Digital Transformation -> Better Patient experience	0.016	0.583	0.56	-0.04	0.069	Not Supported
H12: Patient and HC provider Culture -> Accelerated Digital Transformation -> More HC Provider Facilities	0.011	0.586	0.56	-0.026	0.046	Not Supported
H13: Patient and HC provider Culture -> Accelerated Digital Transformation -> Promoted HCI	0.012	0.554	0.58	-0.029	0.053	Not Supported
H14: Technology and Innovation -> Accelerated Digital Transformation -> Better Patient experience	0.124	3.733	0.00	0.062	0.192	Supported
H15: Technology and Innovation -> Accelerated Digital Transformation -> More HC Provider Facilities	0.082	2.911	0.00	0.033	0.143	Supported
H16: Technology and Innovation -> Accelerated Digital Transformation -> Promoted HCI	0.091	3.185	0.00	0.038	0.152	Supported
H17: HC Business Process -> Accelerated Digital Transformation -> Better Patient experience	0.071	1.966	0.05	0.005	0.137	Supported
H18: HC Business Process -> Accelerated Digital Transformation -> More HC Provider Facilities	0.047	1.838	0.07	0.004	0.101	Not Supported
H19: HC Business Process -> Accelerated Digital Transformation -> Promoted HCI	0.052	1.944	0.05	0.006	0.11	Supported
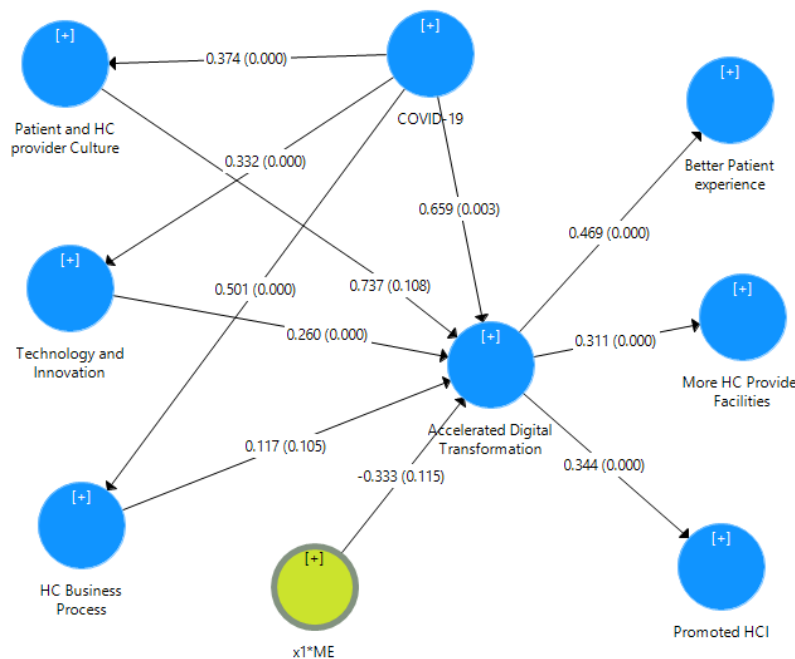
Figure 3. Moderation analysis of COVID-19 on the relationship between Patient and HC provider Culture and Accelerated Digital Transformation

Figure 3 showing the mederator effect from Patient culturer and the Mediator Accelerated digital transformation with $(\beta = -0.333, t = 1.57, P = 0.115, 95\% \ CI \ for \ \beta = -0.776 \ and -0.002)$. this results is not supporting H1a in the study.
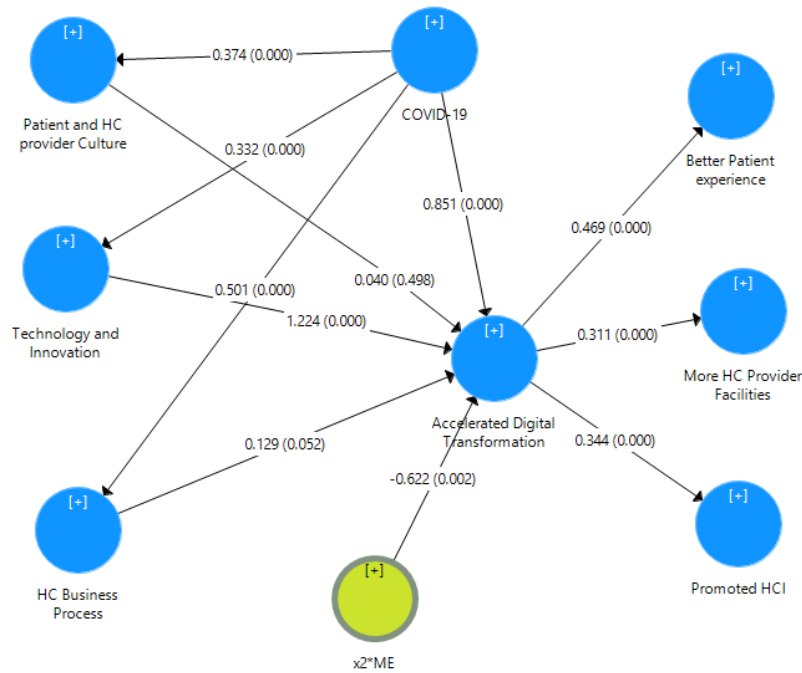

Figure 4. Moderation analysis of COVID-19 on the relationship between Technology and Innovation and Accelerated Digital Transformation

Figure 4 showing the mediator effect from Technology and Innovation and the Mediator Accelerated digital transformation with $(\beta = -0.6.22, t = 3.04, P < 0.002, 95\% \ CI \ for \ \beta = -1.231 \ and -3.56)$. Though that P showing that P has a signifcant effect -ve B shwoing a reserve effect at the same time this results is not supporting H2a in the study.
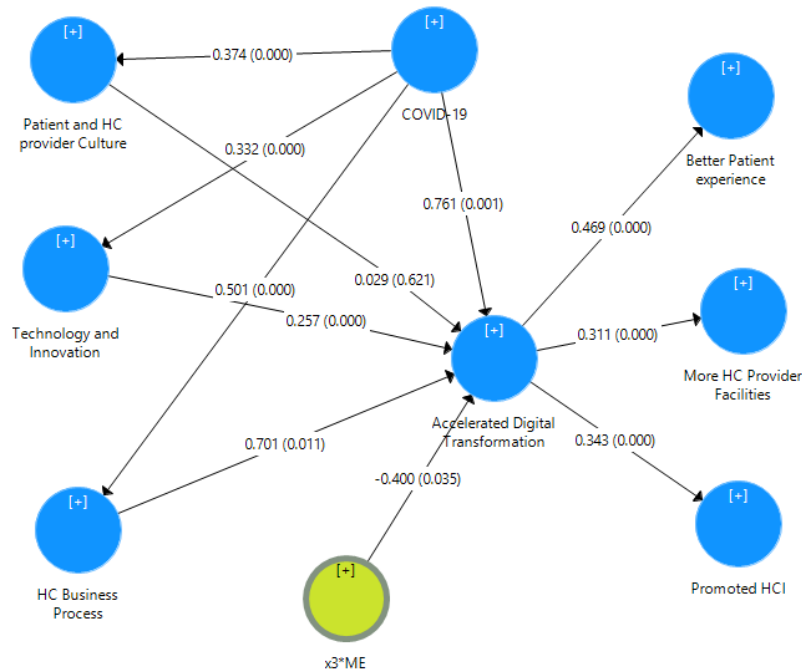

Figure 5. Moderation analysis of COVID-19 on the relationship between HC Business Process and Accelerated Digital Transformation

Table 4. Moderation analysis

Path	B	t-value	P Values	95% for B		Remark
				LL	UL	
H1a: x1*ME -> Accelerated Digital Transformation	-0.333	1.577	0.115	-0.776	-0.002	Not Supported
H2a: x2*ME -> Accelerated Digital Transformation	-0.622	3.049	0.002	-1.231	-0.356	Not Supported
H3a: x3*ME -> Accelerated Digital Transformation	-0.4	2.112	0.035	-0.835	-0.087	Note Supported

15. Discussions

As described in the first chapter, this study included three components considered to be the main drivers of digital transformation and three others to show the impact of accelerated DT. COVID -19 impact were considered positive according to the historical studies. The results were consistent with most of the hypotheses. One of the expectations was the culture of patients and health care providers, which was a major surprise to the researcher. Most historical studies showed a significant impact on the DT. However, Julie Ask with Daniel Hong, Arielle Trzcinski, et al. [37] is one of the studies that showed that the culture of some parties in the health care industry is not ready, even if they did not clearly say so. They showed the resistance of healthcare professionals to some of the technologies that contribute to the magnification of digital transformation (wearable devices and simpler technology). This can be considered a good justification for the results of the survey analysis on the culture of healthcare providers and patients. In addition, the collected information from the survey showed that a significant number of participants (n=142) still prefer physical presence to remote communication or consultation means (n=80) out of the total 245 participants. This also shows that the culture of patients is not yet ready to accept the technologies available in HCI. It is also good that this question was dropped for analysis as it failed validation.

The analysis shows that COVID -19 has a direct impact on all dependent variables (culture, technology, and HC process) and the mediator of the research model (Accelerated Digital Transformation), as shown in the results in Section 20.3.6. Another unexpected fact is that the moderation effect of COVID -19 in the relationship between X1, X2, and X3 and the mediator (Accelerated DT) was not supported by the analysis in Section 20.3.12 (see Figure 2 - Figure 4 and Table 4). These results should be considered in future studies and in the conclusion and limitation of the current study.

Regarding the direct impact of COVID -19 on DT, 216 participants responded to the question "Has the COVID-19 pandemic accelerated digital transformation in healthcare?" and 95.4% (n=206) responded positively to this question. These results are consistent with the direct impact of COVID -19 in the statistical analysis of DT and the historical studies mentioned in a global survey [38], which confirmed a consistent result of 68% and 29% somehow confirmed that digital transformation was greatly accelerated in their organisations.

When predicting the post-pandemic situation in relation to the healthcare sector, 98% (n=197) of participants were in favor of continuing digital transformation. Similarly, in terms of the post-pandemic response (COVID), participants tended to agree that the situation will not return to the old normal, as 68% (n=124) of participants agreed that the situation will not return to the old normal and that new technology will replace the situation. The only justification for this result is that the DT was already in operation before the pandemic, and it is OK to continue with a different kind of law acceleration. The fact that people had to use other means of regular communication to replace physical communication, which was perceived as inconvenient, and the lockdown might have some

influence on the participants' feedback on the post-pandemic situation.
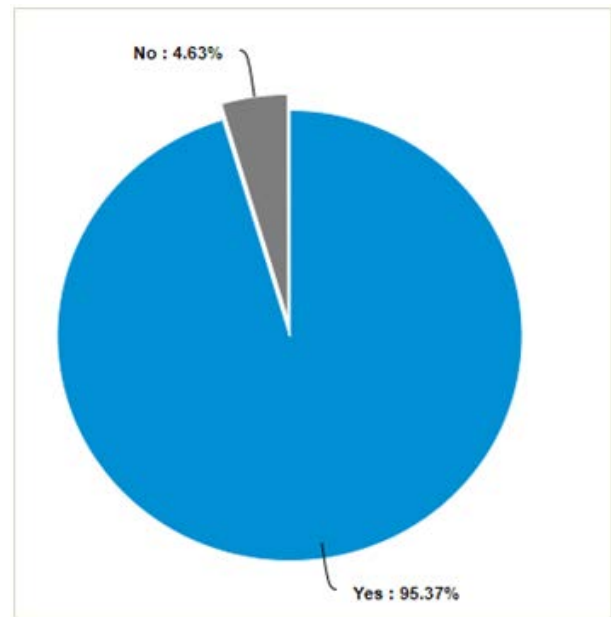

Figure 6. Has the COVID-19 pandemic sped up digital transformation in healthcare?, Results of the survey source: questionpro.com
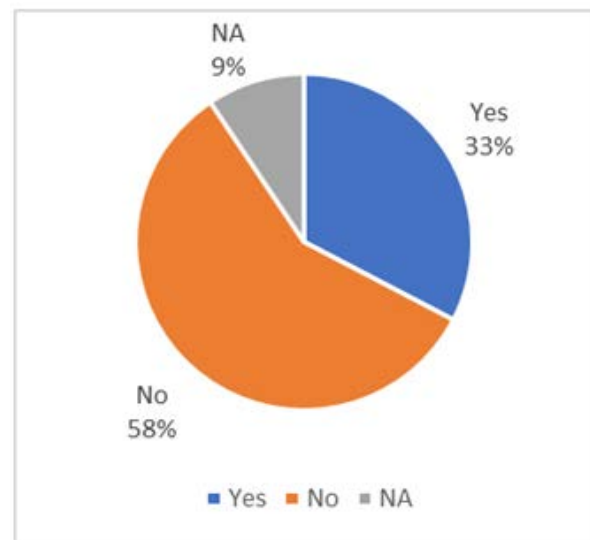

Figure 7. Survey Q: Do you prefer remote consultation than physical presents? (n=245)

16. Conclusions and Recommendations & Limitation

16.1. Conclusion

In line with the objective of this article, this study has succeeded in compiling the drivers and impact of Digital Transformation. The additional effect of COVID-19 as a moderator on the drivers of Digital Transformation was also investigated to see the different effect. Most of the hypotheses were confirmed based on the survey analysis. However, the moderator effect of Covid-19 and its main pillars showed different results from those hypothesized in the study.
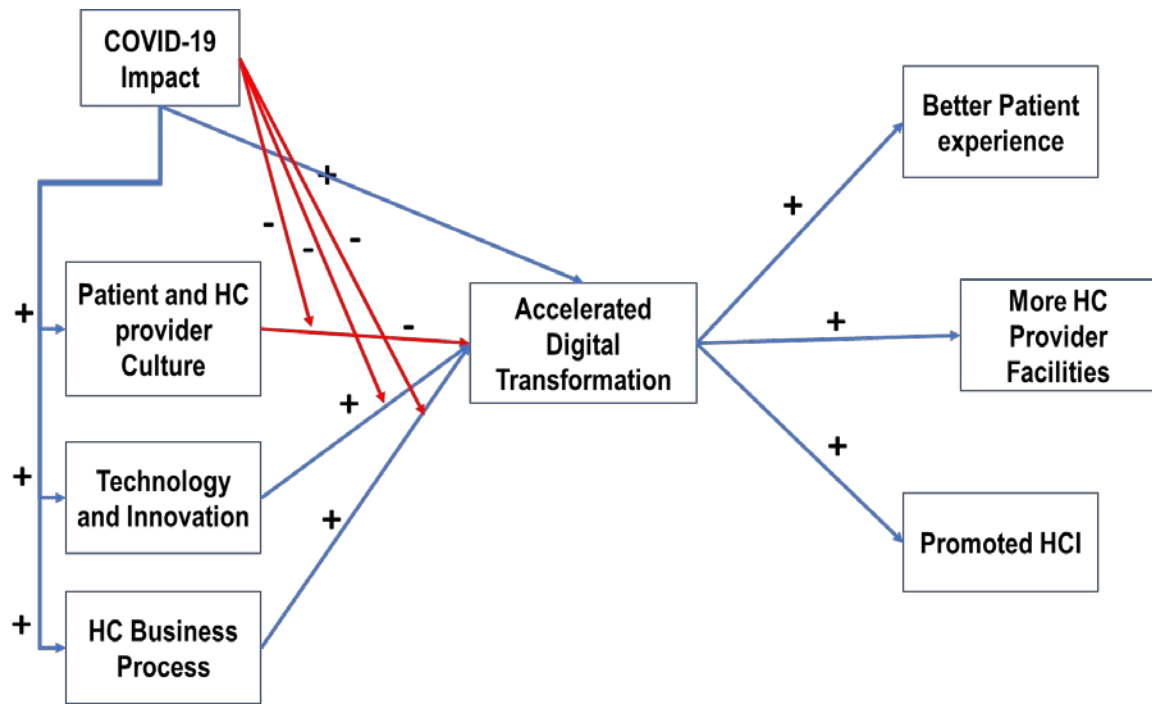
Figure 8. Proposed Model after the Statistical analysis

16.1.1. Direct Effect

Most of the direct effects have been supported by the analysis, with the exception of the relationship between patient and healthcare provider culture and digital transformation, as presented in the statistical analysis section. This indicates that this variable has a legally significant effect on accelerated Digital Transformation. Thus, the statement Patient and HC provider digital Culture are affecting digital transformation (H1) was found to be not significant and the study could not prove this hypothesis. COVID - Table 3 in the analysis section shows that there is a direct correlation with all variables.

16.1.2. Moderator Effect

The moderator effect of COVID -19 has been proven to be not supported. However, the direct effect with the independent variables and the mediator proved to be supported. These results could be due to the small number of moderator effect questions or the limited options in the MCQ questions provided). This can be considered one of the limitations of the study. It is important to highlight that COVID-19 could have some effect, but not as a moderator

16.1.3. Post COVID

Post COVID-19 Hypothesis was tested only on the descriptive analysis H7 to show the feedback and compare it with the previous studies. It was good to see that the historical study is somehow aligned with the collected info from that sample size.

16.2. Recommendations & Limitation

The study may suffer from several limitations, generally related to the method of data collection (questionnaire) and measurement. Participants with low English proficiency were unable to respond to the survey, and this was one of the comments made by the audience and the main reason for the low participation of 52% compared to the numbers seen. Future research needs to consider the bilingual survey for better participation. However, feedback on the number of questions was considered high. The questions on some variables were not sufficient as described in the previous section. The options for each question (Yes/No/ NA) can also be considered as one of the limitations. However, the study aimed to obtain sharp and clear feedback from the participants.

The patients or HC workers with a limited experience in the digital healthcare systems were not detected in this survey and this is considered another limitation. The sample units were collected from only active participants; while others who quit the questionnaire and had no participation during the process may have different perceptions regarding the research concept and variables. Thus, future research may be required to seek an appropriate method to include the perceptions of non-active users.

Other models such as UTAUT can be taken into consideration when creating the conceptual model for the research. In this study, some constructs of the model TAM could be considered to some extent. Future research could incorporate other models such as UTAUT or the model of PC use (MPCU).

The survey was open-ended and had no restriction on the target population from any country or community. However, most participants were from a single country (Egypt). Future research should find a better approach to disseminate the survey worldwide and measure the difference between the acceptance of DT and the impact of COVID worldwide. The study was not able to separately examine responses from countries outside of Egypt because the total number of participants was less than the number needed for analysis.

The study attempted to distinguish between healthcare workers and patients in terms of the impact of digital culture. It is recommended that other studies take this into account and report results for each party separately.

It is important to highlight that COVID -19 could have some influence, but not as a moderator. These results could be due to the small number of questions related to moderation effects or the limited options in the MCQ questions provided. This may be considered one of the limitations of the study survey.

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Annex 01 – Constructs and the set of items to be answered (survey questionnaire)

To validate the hypothesized factors, the following questionnaire was prepared and made available electronically over the internet for the second phase of data collection. Data will be collected from the healthcare workers and any person with a relevant experience with the usage of the new healthcare technology or related to the healthcare industry to explain the scope of the study. Complete and valid questionnaire records was considered, and the response rate was calculated.

	Questions	Constructs	Dimensions
	Main pillars and drivers		
1	Did you use any remote application as a substitute for physical meetings in any medical consultation?	Patient and HC provider Culture	Physical against virtual presents.
2	Did you choose this option freely?	Patient and HC provider Culture	Physical against virtual presents.
3	Do you prefer remote consultation to physical presents?	Patient and HC provider Culture	Patient and health provider digital maturity
4	Did you find this new means of communication helpful?	Patient and HC provider Culture	Perceived Usefulness
5	Was this new virtual presents application easy to be used?	Patient and HC provider Culture	Perceived Ease of Use
6	Did you feel that remote communication is real?	Patient and HC provider Culture	Patient and health provider digital maturity
7	Did you enjoy this experience?	Patient and HC provider Culture	Patient and health provider digital maturity
8	Do you trust the new healthcare tech technology related?	Patient and HC provider Culture	Patient and health provider digital maturity
10	Have you tested connected medical devices to the internet? (IoT, IoMT, AIoT, Wearables, internet weight balance. Etc.)	Technology and Innovation	Disruption, innovation, and technology enabler.
11	Did you have experience saving and sharing your medical record on the Cloud or through remote communication means?	Technology and Innovation	Existing infrastructure
12	Do you think the health system strategy towards orientation towards new technology and changes is in place?	HC Business Process	Strategy
13	Do you think that the financial situation will affect the digital promotion in terms of investments	HC Business Process	investment
14	Do you think healthcare players have Self-motivation; readiness to accept changes?	HC Business Process	Agility to change
	DT and its acceleration because of COVID-19		
15	Do you think that digital transformation Technology has grown in importance in the Healthcare sector during COVID-19?	COVID-19	
16	Do you think health care provider and patients usage of technology increased during the pandemic?	COVID-19	
17	Do you think business continuity and resiliency using Digital Transformation strategies Improved During COVID-19?	COVID-19	
18	Do you think the IoT, IoMT, AIoT, Wearables, internet weight balance Big data and telemedicine are considered Digital Transformation magnification?	DT	DT magnification
9	Have you been exploited with any new tech device in the healthcare area? (Wearable devices, Temp check, digital balances, etc.)	DT	DT magnification
19	Has the COVID-19 pandemic sped up digital transformation in healthcare?	DT	Acceleration
	DT Impact		
20	Do you think digital health communication media (DHCM) usage increased using internet access application?	Better Patient and HC provider experience	Increased patient/physician Engagement. And remote diagnoses
22	Is the knowledge of digital health communication media (DHCM) usage through website platform for Health information in place?	Better Patient and HC provider experience	Better Patient and HC provider digital culture.
23	Is the risk of contracting Covid-19 reduced because of digital health communication media (DHCM)?	Better Patient and HC provider experience	Increased patient/physician Engagement.
24	Do you think that Patient can access health related information through digital health applications?	Better Patient and HC provider experience	Better digital culture
25	Can patients book online appointments for e-consultations with the new means of digital communication?	Better Patient and HC provider experience	Better digital culture
26	Do you think that Patient Healthcare expenses significantly reduced by Using digital health application?	Better Patient experience	Mobility, Cost and Time reduction.

	Questions	Constructs	Dimensions
27	Does patient save transportation costs incurred in visiting hospitals or health care centers?	Better Patient experience	Mobility, Cost and Time reduction.
28	Do you think patients are able to order medicines or medical equipment using e-prescriptions online?	Better Patient experience	Mobility, Cost and Time reduction.
29	Is true that Patients receive personalized care (ex. Conditions like Diabetes, High blood pressure, psychological distress etc.) through digital health applications?	Better Patient experience	Increased patient/physician Engagement.
21	The Patient and HC provider ability to identify useful health resources on the internet increased?	Better Patient and HC provider experience	Better Patient and HC provider digital culture (-Health literacy).
30	Do you think that information relevance, timeliness, completeness, clarity, and accuracy are promoted with the new available digital tech in Health care sector?	More HC Provider Facilities	Better HC provider digital culture.
31	Are digital health services reliable and persist in perfuming the services correctly?	Promoted HCI	Improve HC strategy.
32	Does Digital health services reflect readiness for patients' services?	Promoted HCI	Improve HC strategy.
33	Are Digital health applications effective in creating awareness about Covid-19, its effect, safety procedures and vaccination	Promoted HCI	New products and markets mean.
34	Do you think that DT had made a strong commitment from HC management?	Promoted HCI	Better Health org culture.
35	Do you think that DT had an impact on cross-function collaboration in health sectors?	Promoted HCI	Better Health org culture.
	Post COVID-19		
36	Do you think the new technology will keep transforming Healthcare?	Post Covid	Reddy, M. (2019)
37	How far do you agree that the situation is not going back to normal after the pandemic?	Post Covid	Reddy, M. (2019)