Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Evaluating the Potential and Challenges of IoT in Education and Other Sectors during the COVID-19 Pandemic: The Case of Bangladesh

Nahida Sultana a,*, Marzia Tamanna b

a Department of Business Administration (MIS), Bangladesh University, Bangladesh
b Department of MIS, East West University, Bangladesh

Abstract

The Internet of Things (IoT) adoption affects different sectors immensely, especially during Covid-19. This study mainly examines the benefits and challenges experienced in Bangladesh’s education, and corporate and service sectors while using IoT services during COVID-19. Data collection was performed using a convenient random sampling method and distributing questions online. Two hundred sixty completed responses were analyzed, where 40% of responses were from the education sector, and 60% were from the corporate and service sector. The research method was quantitative and empirical. The study reveals that people find saving time the most potential in education sector, whereas, in the corporate and service sector, the topmost benefit of using IoT services is that it helps strictly maintain physical distance. Conversely, the most significant challenges people face in both sectors are that the IoT increases social distance and reduces individual communication. Nevertheless, people in both sectors have a positive attitude towards using IoT in the future. The findings have practical implications for business professionals, academic scholars, and other associated parties keen to identify IoT impact during the pandemic.

1. Introduction

The Internet of Things (IoT) is now a new paradigm move in IT. The term “IoT,” which is elaborated as “internet of things,” has been formed with two words – ‘internet’ and ‘things.’ Internet is a universal system of computers’ interconnected networks where TCP/IP protocols are used to serve billions of users worldwide [1]. In the information technology world, the internet of things concept is one of the most exciting ones. This concept has attracted massive attraction through the prognosis of the international infrastructure of interrelated physical objects, facilitating anytime, anywhere networking for anything (Kosmatos et al., 2011). Internet of things also can be considered a worldwide network that provides communication or connection between humans to humans and things to things through unique identification of each object [2].

The adoption of the Internet of Things is in many areas. The application initiates with the automation of home to wearable objects. During the pandemic, applications supported by IoT tools are used to minimize coronavirus spread by monitoring the patients, analyzing primarily, and following the specified protocols after the recovery of patients [3]. In Bangladesh, it is also practiced everywhere during COVID-19 [4]. Stated that IoT stands to transform how universities work and improve student learning in several disciplines and any level of education. They itemized some challenges of using higher education in using IoT, including cloud computing, instructional technologies, mobility applications, and privacy and security issues [4]. According to Zhiqiang and Junming [5]; there are three aspects on which the future application of IoT in education depends on students’ progressive evaluation, integrating current teaching platforms, and expanding educational middleware.

IoT is restructuring the modern healthcare system with economic, technological, and social incorporation. Through assembling the Internet of things, the healthcare system is evolving from a traditional to a more modern customized healthcare system facilitating easy diagnosis, treatment, and patient monitoring [3]. In addition to the application in health services is also being practiced as wearable technologies, remote working, drones, robots, data storage, security devices, collaboration tools, distant banking, and e-commerce. Being a developing country, Bangladesh is facing both opportunities and challenges in practicing the services of the Internet of Things during the pandemic situation. First, the usage of IoT services in different sectors is known – here, the sectors are observed from the education and the corporate sector. Then, the benefits and limitations experienced in the sectors while using the services of IoT are examined. After that, people’s

* Corresponding author.
E-mail addresses: nahida.sultana@bu.edu.bd (N. Sultana), marziamis@ewubd.edu (M. Tamanna).

https://doi.org/10.1016/j.techsoc.2021.101857
Received 27 July 2021; Received in revised form 20 December 2021; Accepted 30 December 2021
Available online 6 January 2022
0160-791X/© 2022 Elsevier Ltd. All rights reserved.
attitudes toward using IoT services can be found. Notably, the following research questions have been addressed:

**RQ1.** What benefits and challenges are experienced in the education sector in using IoT services during COVID-19?

**RQ2.** What benefits and challenges are experienced in the corporate and service sector in using IoT services during COVID-19?

**RQ3.** How are the attitudes towards practicing IoT during COVID-19?

### 1. Research objectives

This research aims at understanding the opportunities and challenges of the Internet of Things in Bangladesh during COVID-19. Specific objectives include:

- To examine the benefits and challenges experienced in the education sector using IoT services during COVID-19.
- To discover benefits and challenges experienced in the corporate and service sector using IoT services during COVID-19.
- To analyze the attitudes towards practicing IoT during COVID-19.

### 2. Literature review

IoT can help link all intelligent objects with advanced technologies without human interactions in a network. However, according to Mohammed [6]; IoT is a new research topic with significant substantial research ground in recent years.

Response to COVID-19 effects digital tools is being used to promote public health, including population monitoring, event recognition, touch tracking, and action assessment on engagement with the mobility of data and the public [7]. The creation and deployment of emerging technology are strongly motivated to address the economic deficiencies posed by COVID-19. In the war against COVID-19, many modern digitalization defense and government strategies have been implemented. During this time, innovations and digital technologies gradually became humanity’s strongholds. In the developed world, to achieve SDGs (sustainable and digitalization goals), the potential of the IoT would have a significant impact. Islam [8] stated that in attempts to control the emerging pandemic, the advanced technology and integrated position of the IoT have the potential. IoT-enabled devices and applications are used to surveillance the patient, stated protocol practice, and primary detection process to minimize the possible spread of the Coronavirus.

Javaid [9] stated that IoT helps send and receive physical objects and information through the Internet. As a part of this, numerous medical devices, advanced imaging devices, diagnostics, and artificial intelligence are used in the medical field. IoT facilitates connection from healthcare systems to smart cities, homes, cars, and entertainment systems. Wire and wireless Internet control the smart hospital devices. Intelligent devices can capture data and share it in real life. These advanced technologies and devices improved the productivity and quality of life in both old and new societies and industries [Farr, 2020].

In monitoring healthcare during the COVID-19 pandemic, this technology is booming. The IoT interrelates all digital, mechanical computing technologies to transfer data through the Internet without any human interaction. According to Nasajpour [3]; for further help, all the COVID-19 patient-related information provided the proper attention and stored in the cloud. In this critical situation, many people died due to improper and untimely information about health. IoT helps notify the health system about health-related issues by using sensors; it captures routine activities and alters the health issues [10]. There is an essential requirement for the proper equipment to confirm effective operations in the medical field. The applications of IoT contribute superior care to the COVID-19 pandemic. To transfer essential health facts to the physician’s intelligent medical devices and connecting devices are used. These devices monitor real-time data successfully with the help of IoT that saves lives from different health problems, and it also helps to provide after services and analyze capabilities to successful operations [9].

According to Müller [11]; In a network, IoT is a cyber-physical system without any human intervention in which mechanical and digital machines exchange data. IoT incorporation and consumer applications use cloud computing, real-time analytics, machine learning, robotics, and sensors to automate the processes thoroughly. In this pandemic crisis, many companies have the chance to reconsider their business process and start over. For example, intelligent manufacturing facilities connected and connected assembly lines to exchange data, lessened order times, shorter cycle time, higher production flexibility, forecast events, and without difficulty deciding how to deal with problems [10].

Because of COVID-19, the use of smart devices is speeding up. In the trending industry, smart houses are the trendiest ones. The IoT has an extended experience network that helps to improve waste management and work with the traffic. It also helps to sensor the fire and flood for making the houses safer. The software can consider video footage to examine whether large offices abide by the social-distancing rules. Infrared cameras were used in train stations and airports [12].

For implementing the interconnected technology, those who provide the services and the infrastructure are mostly contact-free. IoT services provide cloud systems, data security, retail operations, and data storage to oversee and integrate the factory process. The hardware ranges from 3D printing for additive manufacturing and assistive industrial robots to semiconductors and sensors [13]. According to Israel [14]; in 2020, many of us have taken remote work from home; that is why we have seen the widespread use of collaboration platforms and cloud computing. Where the physical presence is necessary, remote monitoring systems will become more commonplace in 2021. Either in person or remotely, employees can remotely monitor the automated manufacturing processes when an issue requires human interaction in industrial operations.

Many smaller and giant merchants keep their businesses open virtually in this pandemic situation. IoT also advanced the online retail industry. For example, Amazon & Walmart automate the distribution centers and supermarkets and make it human contract less using radio frequency identification (RFID) and robotics to help continue contact-free payment. It is common to track the retail industry’s inventory and collect data on customers’ purchases that improve shoppers’ in-store experience. To grow contact-free and cashless payment options Samsung, Apple and Google have some apps options [7].

According to UNDP [15]; the IoT to the pandemic response measures the contribution of emerging technology. Sustainability and digitalization shaped the factors like climate, economy, and culture. The emerging COVID-19 pandemic and the growth of new digital technology have effectively systemized the equation. However, few scholars have considered the IoT’s ability to achieve SDGs in emerging regions.

Singh [16] stated that the evolution of the IoT reshaped economics, modern healthcare systems and incorporated technological and social prospects. IoT has become an efficient technological adoption in this COVID-19 situation due to lower expenses, advanced user experiences, and better quality of services. Modern healthcare systems provide more personalized systems to help diagnose, monitor, and treat patients remotely. In 2021, March 29, WHO showed globally 2, 2,769,473 deaths and 126,359,540 confirmed cases of COVID-19. By the RT-PCR [17] in Bangladesh, there were 595,714 confirmed cases of COVID-19 and 8904 deaths [18]. Radanliev and De Roure [19] did not mention the effects of multifaceted and coupled risks from IoT systems but focused on the IoT ethical and design update. To guide developing a framework for governments, medical organizations, and healthcare practitioners, IoT brings greater risk. With the ethical consideration of the cyber risks, new technologies must be combined with supply chains [20].

An abstract epistemological framework is offered based on the digital humanities tools during the COVID-19 period. This epistemological framework, designed by researching qualitative data samples on COVID-
3. Respondents’ demography

Fig. 2 and Table 2 demonstrate the demographic information of the participants.

3.4.1. Age

From Fig. 2, we can interpret that most of the respondents were below 35. 21% of male people were below 25, 31% were below 35. Of the male respondents, 5%, 3%, and 2% were below 45, below 55, and 55 or above, respectively, in the age category. However, among the female participants, 12%, 19%, 4%, 2%, and 1% were below 25, below 35, 36–44 years, 45–54 years, and 55 or above ages, respectively.

3.4.2. Gender

Table 2 indicates 65% male participants and 35% female participants.

3.4.3. Education

As shown in Table 2, among the 260 participants, 45% belonged to a bachelor’s degree, 49% belonged to a master’s, and 6% belonged to a Ph.D.

3.4.4. Field of expertise

Table 2 shows that 40% are in the education field. In the corporate and service sector, the respondents are asked to select areas (more than one) they are practicing IoT services. Data shows that most of the participants (36%) belonged to the corporate workplace, 28% in Bank, and 15% were in the medical field.

3.5. Reliability and validity of research instrument

The reliability of the research instrument evaluates the consistency of the scale items within the construct [24, 25]. Reliability testing shows the extent to which the research instruments are error-free. Cronbach’s alpha (α) is a standard measure of scale reliability and internal consistency of the items [26]. This (α) can be computed by correlating the score of each scale with the score sum of each observation and then comparing that to the variance of individual item scores [27]. The mathematical formula for this:

\[ \alpha = \frac{k \times \bar{c}}{n + (k - 1)\bar{v}} \]

where k = number of scale items, c = average of all covariances between items, and v = average of variances of each item.

Here, Cronbach’s alpha value, Cronbach’s alpha, if item deleted, and corrected total item correlation are used to evaluate the two constructs’ consistency and reliability. As shown in Table 3, the coefficient value of Cronbach’s alpha for the benefits of using IoT was 0.832, and for the challenges of using IoT was 0.808. According to Rivard and Huff [28]; Cronbach’s values above the alpha coefficient of 0.7 deliver reliability...
**Table 1**

Operational definition [23].

| Variables identified (benefits and challenges) | Operational definition |
|-----------------------------------------------|------------------------|
| B1. It allows contactless work.                | Computerizing the practice provides easiness and accessibility (Israel, 2020). |
| B2. It saves time                             | Automation supports time minimization. |
| B3. It saves cost                             | Process optimization reduces cost by reducing and prioritizing the impact of productivity (Andrew Farr, 2020). |
| B4. Services are available at any time        | Authorizes users have 24/7 accessibility. |
| B5. Services are convenient                   | IoT improves delivery services, reduces costs by automating the process, and reduces labor costs [22]. |
| B6. Ensures security in transaction/data processing | Technologies like consensus mechanisms, smart contracts, decentralization, and data encryptions are appropriate for building distributed IoT systems to avoid occurrences [8]. |
| B7. Easy to use                               | IoT processes are easy and precise to understand and use [16]. |
| B8. Facilitates location-based services        | Location-based services or LBS enrich control and discernibility [20]. |
| B9. Strictly maintains physical distance.     | All businesses use human contactless systems like radio frequency identification (RFID) and robotics to strictly maintain physical distance [6]. |
| B10. Reduces manual job                        | Fully automated processes in IoT incorporation and consumer applications use cloud computing, real-time analytics, machine learning, robotics, and sensors that help reduce manual work [20]. |
| B11. Facilitates the communication             | Using the IoT-enabled devices with networking, connectivity, and communication protocols facilitates communication [11]. |
| B12. Easy to access information               | Easy to access information from anywhere, anytime from any device. |
| C1. It seems complex                           | It seems complex from the application perspective, but the technology makes it more convenient (Roure, 2021). |
| C2. Compromises data privacy                  | Compromised devices that can be used to access personal data is one of the IoT’s Security and privacy concern [6]. |
| C3. Increases social distancing               | IoT helps employees to do remote work from anywhere. |
| C4. Reduces personal interaction               | Remote industrialization, remote work, contract fewer services cut out personal interaction [9]. |
| C5. Lesser jobs/loss of jobs                  | Increased use of technologies lessens the number of employments. |
| C6. The mounting number of frauds             | New IoT connections create new fraudsters, skimmers, identity thieves and hackers [1]. |
| C7. Technological complications               | Security issues, limited bandwidth, lack of regulation, and skill [10]. |
| C8. Mobility challenges                       | End-to-end delay, increased signaling cost, packet loss, power consumption, and increased handover latency create mobility challenges (Mohammad Nanaipour, 2020)). |
| C9. Unauthorized access to data               | Availability of data creates these issues. |
| C10. Lack of flexibility                      | The lack of architectural and simulation models lacks flexibility [7]. |

Evidence for the internal consistency of measurement scales.

The constructs’ values, closer to 1, are more reliable [29]. As Cronbach’s coefficient values for the identified two constructs are above 0.8, it can be determined that the research instrument is a reliable research tool. Furthermore, if one item from the constructs was deleted, Cronbach’s alpha was also calculated, and the ranges were 0.810–0.840 and 0.780–0.813, respectively, which were above the standard value of 0.70.

Exploratory factor analysis (principal component) analyzes the constructs’ validity. Hair et al. [30] stated that values of factor analysis greater than 0.30 are significant, values greater than 0.40 are more significant, and values equal or greater than 0.50 are highly significant. Therefore, factor loading is used to measure research construct validity.

Item-total represents the correlation between each item and the total scale score. For the exploratory study, 0.20 is acceptable for item-total correlation [31].

**Table 2**

Profile of the participants.

| Question                                      | Frequency (n = 260) | Percentage |
|-----------------------------------------------|---------------------|------------|
| Gender                                        |                     |            |
| Male                                          | 170                 | 65%        |
| Female                                        | 90                  | 35%        |
| Education                                     |                     |            |
| Bachelors                                     | 118                 | 45%        |
| Masters                                       | 127                 | 49%        |
| PhD                                           | 15                  | 6%         |
| Field and area of use                         |                     |            |
| Education sector                             | 106                 | 40%        |
| Corporate and service sectors                 | 154                 | 60%        |
| Medical                                       | 39                  | 15%        |
| Wearable devices                              | 32                  | 12%        |
| Workplaces                                    | 95                  | 36%        |
| Merchandise                                   | 24                  | 9%         |
| Bank                                          | 74                  | 28%        |
| Smart Home                                    | 41                  | 15%        |

**Table 3**

Summary of the findings of reliability Test.

| Construct                                      | No. of items | Mean Cronbach Alpha | Cronbach’s Alpha if Item Deleted | Range of corrected item-total correlation |
|------------------------------------------------|--------------|---------------------|----------------------------------|------------------------------------------|
| Benefits of using IoT services                 | 12           | 3.896               | 0.832                            | 0.810–0.840                             | 0.407–0.617 |
| Challenges in IoT services                     | 10           | 3.595               | 0.808                            | 0.780–0.813                             | 0.427–0.586 |

As shown in Table 4, the values of benefits of IoT services (labeled as B1 – B12) construct generated factor loading range from 0.51 to 0.72, and IoT (labeled as C1 – C10) construct generated factor loading range from 0.54 to 0.75. Thus, the construct validity of the study instruments is highly significant.

4. Result analysis

4.1. Benefits and challenges in the education sector while using IoT

The constructs used to examine the benefits experienced while using IoT services include 12 items (Table 1). The participants were asked to rate these 12 items using a five-point Likert scale ranging from “1 = Strongly Disagree” to “5 = Strongly Agree”.

As shown in Table 5, the results indicate that the topmost benefit experienced in the education sector in using IoT services is “B2: It saves time” (Mean = 4.24). The factor denotes that the teachers get enough time to prepare and manage class, and students do not need to go to the classroom by spending time on the road or in traffic jams. This result supports the factors affecting technology facilitation from teachers’ perspectives [32]. The second top benefit in the education sector is “B9: It helps maintain physical distance” (Mean = 4.22) strictly. This finding supports some theoretical benefits indicated in several studies regarding the importance of using the IoT in maintaining physical distance during COVID-19 [10–13]. The third one is “B12: Easy to access information” (Mean = 4.01). The factor denotes that teachers take advantage of virtual reality in any practical classes through easy access online, and students can access recorded or uploaded learning materials. This result supports the finding of excellence in learning and teaching activity through IoT adoption [11,33]. The following ranked benefits observed in the education sector include “B10: reduces manual job”, “B7: easy to use”, “B11: Facilitates the communication”, “B1: It allows contactless work”, “B8: Facilitates location-based services”, “B4: Services are available at any time”, “B5: Services are convenient”, “B3: It saves cost”,...
and “B6: Ensures security in transaction/data processing”.

The constructs used to examine the challenges experienced in the education sector while using IoT services consist of 9 items (Table 5: Column 4). The results reveal that the highest-ranked challenge faced while using IoT services in the education sector during COVID-19 is “C3: increasing social distancing” (Mean = 4.03). Most people agree that the use of IoT is increasing social distance. This top challenge supports the findings regarding IoT use prone to social distancing [12]; Forum, 2020). The third-ranked challenge is “B2: It helps maintain physical distance” (Mean = 4.19), strictly. People in the corporate and service sectors find this benefit most apparent during pandemic situations. This finding supports the theoretical benefits indicated in a few studies regarding the importance of using the IoT in maintaining physical distance during COVID-19 [10–13]. The second potential found in using IoT in this sector is “B4: Services are available at any time” (Mean = 4.14), which denotes that people have services from anywhere at any time. This finding supports health diagnosis and data access [3,9,40]. The third potential is “B2: It saves time” (Mean = 4.10). This result supports several studies’ theoretical and empirical benefits regarding saving time in shorter cycles, decreased order times, and real-time analytics [9,11]. The subsequently ranked potentials observed in the corporate and service sectors include “B7: Easy to use”, “B1: It allows contactless work”, “B11: Facilitates the communication”, “B12: Easy to access information”, “B3: It saves cost”, “B10: Reduces manual job”, “B8: Facilitates location-based services”, “B5: Services are convenient”, and “B6: Ensures security in transaction/data processing”. The least ranked IoT potential in the corporate and service sector is “B6: Ensures security in transaction/data processing (Mean = 3.60). Very few studies have been found regarding data security. However, fraudulence and violation of data privacy are on the rise during the pandemic. Therefore, more attention is required to improve the security of data processing.

Challenges experienced in the corporate and service sector while using IoT services are examined using the construct consisting of 10 items (Table 6: Column 4). The results reveal that the highest top two ranked challenges are the same as observed in the education sector; “C3: increasing social distance” (Mean = 3.95) and “C4: Reducing personal interaction” (Mean = 3.81). These support the findings regarding IoT use prone to social distancing [12]; Forum, 2020). The third-ranked challenge is “C6: mounting number of frauds”, which denotes the services through a centralized system might lead to corruption, fraud, and falsifying information. The finding supports analysis regarding traceability systems based on IoT [41]. The following ranked challenges of using IoT services in the corporate and service sector include “C7: Technological complications”, “C9: Unauthorized access to data”, “C8: Mobility challenges”, “C2: Compromises data privacy”, “C5: Lesser jobs/loss of jobs”, “C10: Lack of flexibility, and “C1: It seems complex”.

4.3. Attitude towards using IoT services

The attitudes towards using the services of IoT have been examined through two dimensions – positive attitude and negative attitude. Table 7 shows the results observed in the education sector and the corporate and service sectors. There are significant differences in attitude between these two sectors. In the education sector, out of 106 respondents, 55% agreed to the positive attitude statement of using IoT in the future, while in the corporate and service sector, 52% of 154 respondents have a positive attitude towards using IoT. A tiny percentage of the negative attitude statement has been found in both sectors in terms of the negative attitude statement. In education, its 13% and incorporate and service sector, the percentage is 14%.

There are potentials and lights of hope of increasing the use of IoT in both sectors. However, a remarkable number of people remained neutral in both positive and negative attitude statements, as shown in the table. Therefore, challenges identified in the sectors should be adequately addressed to increase the positive attitude among people.

Table 4
Validity testing through factor loading.

| Benefits | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 | B10 | B11 | B12 |
|----------|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| Benefits | .652 | .626 | .575 | .634 | .720 | .559 | .625 | .584 | .652 | .506 | .634 | .706 |
| Challenges | .576 | .577 | .753 | .597 | .539 | .583 | .696 | .712 | .688 | .715 | .689 | .715 |

Table 5
Benefits and challenges in the education sector in using IoT services.

| Benefits | Means | Rank | Challenges | Means | Rank |
|----------|-------|------|------------|-------|------|
| B2: It helps maintain physical distance | 4.24 | 1 | C3: Increasing social distancing | 4.03 | 1 |
| B9: Services are available at any time | 4.22 | 2 | C4: Reducing personal interaction | 3.91 | 2 |
| B12: It seems complex | 4.01 | 3 | C7: Easy to use | 3.81 | 3 |
| B10: It allows contactless work | 4.00 | 4 | C5: Easy to access information | 3.78 | 4 |
| B7: It helps maintain physical distance | 3.99 | 5 | C8: Facilitates the communication | 3.63 | 5 |
| B11: It saves time | 3.92 | 6 | C9: Services are convenient | 3.58 | 6 |
| B1: It saves cost | 3.83 | 7 | C10: Mounting number of frauds | 3.58 | 7 |
| B8: Easy to use | 3.82 | 8 | B3: It seems complex | 3.39 | 8 |
| B4: Services are available at any time | 3.75 | 9 | C1: It seems complex | 3.25 | 9 |
| B5: Services are convenient | 3.75 | 10 | B2: It helps maintain physical distance | 3.25 | 10 |
| B3: It seems complex | 3.72 | 11 | B9: Services are available at any time | 3.28 | 11 |
| B6: Ensures security in transaction/data processing | 3.58 | 12 | B12: It helps maintain physical distance | 3.28 | 12 |

Table 6
Benefits and challenges in corporate and service sectors in using IoT services.

| Benefits | Means | Rank | Challenges | Means | Rank |
|----------|-------|------|------------|-------|------|
| B9: It helps maintain physical distance | 4.19 | 1 | C3: Increasing social distancing | 3.95 | 1 |
| B4: Services are available at any time | 4.14 | 2 | C4: Reducing personal interaction | 3.81 | 2 |
| B2: It allows contactless work | 4.10 | 3 | C5: Easy to access information | 3.69 | 3 |
| B7: It helps maintain physical distance | 3.97 | 4 | C7: Easy to use | 3.55 | 4 |
| B1: It saves cost | 3.95 | 5 | C9: Services are convenient | 3.51 | 5 |
| B11: It saves cost | 3.95 | 6 | C8: Facilitates the communication | 3.47 | 6 |
| B12: It allows contactless work | 3.94 | 7 | C2: Compromises data privacy | 3.44 | 7 |
| B3: It seems complex | 3.85 | 8 | C10: Lack of flexibility | 3.44 | 8 |
| B10: It saves cost | 3.83 | 9 | C1: It seems complex | 3.28 | 9 |
| B8: Easy to use | 3.79 | 10 | B3: It seems complex | 3.28 | 10 |
| B5: Services are convenient | 3.73 | 11 | B9: Services are available at any time | 3.28 | 11 |
| B6: Ensures security in transaction/data processing | 3.60 | 12 | B2: It helps maintain physical distance | 3.28 | 12 |
5. Conclusions

Activities without human interaction are progressively driven by the Internet of Things (IoT) during current new normal situations. The study outlines the benefits and challenges experienced by people in diverse sectors. The findings demonstrate that younger people (below 35 years of age) are more likely to use the Internet of Things services in different sectors. In the education sector, the topmost opportunity is that it saves time because teachers have enough time for class preparation and management, and students can save time by attending class from anywhere, avoiding traffic jams. In other fields such as the corporate and service sectors, maintaining strict physical distance has been found to have the most potential in using IoT services during a pandemic. However, challenges experienced in all sectors include increasing social distance and reducing personal communication.

5.1. Theoretical implications

This study provides a substance for future researchers to study the users’ experiences using IoT in Bangladesh during COVID-19. Very few studies were found regarding IoT service experiences in Bangladesh during the pandemic crisis. Therefore, this study will assist in finding the benefits and challenges faced by IoT users, particularly in the education, and corporate and service sectors during the pandemic. Further research can also be possible by proposing a model to overcome challenges in using the IoT. Furthermore, the sample size might include the rural population, reflecting the entire scenario of users’ experiences regarding IoT services in this pandemic time.

5.2. Practical implications

The study supports the organizations to adjust quickly and respond promptly to the growth of IoT services and examine the challenges and benefits of adopting IoT in different sectors. The findings of emerging countries such as Bangladesh act as a realistic roadmap for applying IoT technologies. Instead of reducing work opportunities, the IoT creates more straightforward work practices and jobs. In hospitals, financial organizations, education, utilities, and others, IoT has enabled improvements to significant facilities, which gives a modern scheme to technology advancement. The outcomes may help the educational institutions and other sectors identify the potentials and experienced challenges in using IoT and attitudes of people towards the future use of IoT, then enlighten them to act accordingly to improve the future experience. In addition, this will benefit further application and increase technology usage.

Authorship statement

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before its appearance in the Hong Kong Journal of Occupational Therapy.

Authorship contributions

N. Sultana: Conception and design of study: Idea, Sampling method, Analytical method; acquisition of data: Questionnaire development; analysis and/or interpretation of data: reliability testing, validity testing, descriptive analysis, interpretation. Drafting the manuscript: editing, research framework design; revising the manuscript critically for important intellectual content: grammar checking, revising and updating the analysis. Approval of the version of the manuscript to be published (the names of all authors must be listed): Nahida Sultana, Marzia Tamanna. N. Sultana, M. Tamanna: Conception and design of study: Literature Review, Theoretical framework, Implication; acquisition of data: Data collection, secondary data acquisition, analysis and/or interpretation of data: interpretation. Drafting the manuscript: editing, updating; revising the manuscript critically for important intellectual content: Reference checking, updating the format, compilation. Approval of the version of the manuscript to be published (the names of all authors must be listed): Nahida Sultana, Marzia Tamanna.

Justification of omitting an author

This is to inform that we had another author in the previous original submission. But it’s unfortunate to inform that the author didn’t make any substantial contributions to the work reported in the manuscript. We added him for funding purpose; however now we, other two authors made decision to omit him as author.

Acknowledgements

All persons who have made substantial contributions to the work reported in the manuscript (e.g., technical help, writing and editing assistance, general support), but who do not meet the criteria for authorship, are named in the Acknowledgements and have given us their written permission to be named. If we have not received substantial contributions from non-authors.

References

[1] S. Madakam, V. Lake, V. Lake, V. Lake, Internet of things (IoT): a literature review, J. Comput. Commun. 3 (2015) 164, 05.
[2] R. Aggarwal, M.L. Dai, RFID security in the context of internet of things, in: Proceedings of the First International Conference on Security of Internet of Things, 2012, pp. 51–56.
[3] M. Nasajpour, S. Pouriyeh, R.M. Parizi, M. Dorodchi, M. Valero, H.R. Arabnia, Internet of Things for current COVID-19 and future pandemics: an exploratory study, Journal of healthcare informatics research (2020) 1–40.
[4] H. Aldkowah, S.U. Rehman, S. Ghazal, L.N. Umar, Internet of Things in higher education: a study on future learning, J. Phys. Conf. 892 (1) (2017), 012017). IOP Publishing.
[5] H. Zhijiang, Z. Junming, The application of Internet of Things in education and its trend of development [J], Modern Dist. Educ. Res. 2 (19) (2011).
[6] T. Mohammed, C. Jean-Yves, B. Peter, R. Christophe, Petrogenesis of the post-collisional Bled Mena volcanic ring complex in Reguitat Rist (western Eglab shield, Algeria), J. Afr. Earth Sci. 166 (2020), 102250.
[7] D.A. Walcott, How the Fourth Industrial Revolution can help us beat COVID-19, in: World Economic Forum, 2020. Retrieved from, https://www.weforum.org/agenda/2020/05/how-the-fourth-industrial-revolution-can-help-us.Handle-the-threat-of-covid-19.
[8] A. Islam, K. Anum, D. Dwivediavanati, S. Wahab, A. Abdul Latif, Building a post COVID-19 configuration between Internet of Things (IoT) and sustainable development goals (SDGs) for developing countries, J. Arts Soc. Sci. 4 (1) (2020) 45–58.
