

Towards deployment of IoT in ICT at Pakistan - Upcoming Challenges and Best Efforts Implementation

Mohammad Imran Mushtaque¹, Shahid Ali Mahar^{1*}, Muhammad Kashif¹, and Asma Batool²

¹Shah Abdul Latif University, Khairpur, 66020, Pakistan.

²Department of Computer Science, Virtual University, Pakistan.

Corresponding Author: Shahid Ali Mahar. Email: shahid.mahar@salu.edu.pk

Received: January 01, 2024 Accepted: May 05, 2024 Published: June 01, 2024

Abstract: Internet of Things (IoT) has become the new research area and being tested in closed environment to be deployed in real world. On the other hand, emergence of IoT in Information and Communication Technology (ICT) is an essential ingredient of technological development but even then it is not fully adopted especially in under developed countries. This research investigates the current status of IoT in ICT with respect to Pakistan and the challenges and efforts taken by the Pakistani Government and Institutions. This research reveals the current status and related issues of IoT in ICT so that swift measures may be taken to cope up with the situation in order to get enhance economic and technological advantage.

Keywords: Internet of Things (IoT); Information and Communication Technology (ICT); ICT in Education; ICT Challenges.

1. Introduction

Information and Communication Technology (ICT) actually refers to the computers, internet and the electronic data communication system [1] and is being used globally in every sector of the world, like economy, education, health, science & technology, agriculture, defense, etc. Internet has reduced the geographical gaps and the world has become the global village [2]. Now every piece of information is in your figure tips and just away from a single click. Even in various cases, we do not need to click, we just give instructions in our own voice, and the task will be accomplished [3]. We can share any information to the world using various channels through ICT [4]. We use websites, online social networks like facebook, twitter, instagram, blogs, youtube channels, etc to share our statuses or information to make the world known. ICT facilitates watching live coverage of the events and occasions without being a part of that [5]. It has changed the concept of learning environment. Now online courses are offered to make us expert in any field. We are supposed to be enrolled on website for a particular course instead of an academy or institution. This facilitates to those, who do not have much time to attend classes physically, or unable to join school or academy due to any other reason [6]. On the other hand, smart offices or mobile office is also a remarkable concept given by ICT [1]. Having laptop and internet connection can make you start your office anywhere. You are in travel or you are in bed, you can start your office. Similarly, ICT is going to convert the whole world to the paperless environment, where no need to have a printed document [7]. Whatever the information we need, is available in soft copy over the internet. Even currently, we enjoy paperless money, online exams, emails instead of traditional letters on paper, digital books and libraries, PDAs [8], etc. Surveillance is now being done through ICT [9]. It has become mandatory to share information instantly from one point to another to keep updated in all aspects so that the right decisions may be taken as per the shared information [10]. This shows that the implementation and adoption of ICT is now unavoidable for every country, sector or segment. But adoption of ICT is not much easy especially in under develop countries comparatively the developed countries [10]. This requires the complete infrastructure, which includes both human and non-human resources [11]. In order to implement ICT in

under develop countries, different challenges and issues are supposed to be faced and managed. These challenges may vary according to culture, economy, political strength, geographic positions, climate, etc [12]. This research is focused with Pakistan and the education system of Pakistan to depict that what are the issues and challenges, which are being faced in implementing ICT in the education system of Pakistan. In conclusion, Information and Communication Technology (ICT) has revolutionized various sectors globally, transforming the world into a connected "global village." It facilitates instant information sharing, remote work, online education, and a shift towards a paperless environment. Despite its widespread benefits, implementing ICT in underdeveloped countries like Pakistan faces significant challenges, including infrastructure deficiencies and socio-economic barriers. This research highlights the specific obstacles within Pakistan's education system, emphasizing the need for a comprehensive approach to overcome cultural, economic, and political challenges to fully integrate ICT into the educational framework.

1.2. Advantages of ICT in Education

There are many advantages of ICT especially in education, which are extolled by various researchers. Some of them are hereby listed below.

1.2.1. Access of digital information in effective and efficient manner

ICT as a tool is being used to find the learning topics for the students. It is also used to solve problems and discover the multiple solutions of such problems, which makes the learning process easier for the students [13]. ICT engages the students in accessing knowledge and make this knowledge understood in different ways, which is more convenient to the students [14].

1.2.2. Support self-directed and student-centered learning

Computers are now frequently used by the students in order to engage them for their studies [4]. They create fresh knowledge by accessing data and information. Then they select the data as per their need and organize it for interpreting the theme of that knowledge. With the help of ICT, the students have become more competent to collect data and information from different sources and accessing it more critically to assess the quality of learning material [15].

1.2.3. Create a productive learning environment

ICT has evolved the new comprehension level for students in various learning areas [16]. ICT is producing more dynamic explanations to various kinds of problems. For instance, if we talk about reading class, where students are supposed to read the books, digital books are being used for reading activities. Students can use different types of text books from initial level to professional level by the help of computers, tablets PCs, PDAs, iPads, etc [17]. Many digital books for reading activity also contain reading applications. These applications provide reading interface, games which helps the students to enhance their reading skills, vocabulary enhancing activities, and much more. It shows that ICT provides special purpose applications, which gives the new methods to enhance learning capabilities as per needs [18].

1.2.4. Support in distance learning educational

ICT has enabled the students to share, communicate, and work together anytime and anywhere [19]. For example, a class on teleconference invites the students all around the globe together at the same time for any collaborative discussion. This will make them able to assess the problems, find the proposals and to build up the concepts. Then they can evaluate the solutions with the help of other peers by using ICT [20]. In this practice, the they not only get the knowledge but also exchange different learning experiences with others to show their assessment level and learning capabilities, which may result in order to learn from others' experiences and enhance expertise in the domain as well [21]. It also helps to meet some other researchers in the same field, who can share their research findings to make the beginners aware with the latest work and also the gaps in the domain. ICT enables global student collaboration, enhancing problem-solving, knowledge exchange, and expertise through teleconferences and peer interactions.

1.2.5. Facilitate in order to develop critical thinking skills

Keeping in view the concept of new approach like constructive learning, ICT facilitates the students to be focused on broader concepts instead of small tasks [Srinivasan, 2019]. Statistics shows that there is correlation between critical thinking development and the study based on ICT [23]. The critical thinking may be developed because of ICT, as it enhances the process thinking development and gives huge exposure. That's why, it is recommended to adopt ICT in schools, colleges, universities and institution in every area ops study for better learning. Those institutions, which have implemented ICT, are more result oriented and the students of such institutions are better in terms of critical thinking. Adopting ICT in

education fosters critical thinking, broadens concept focus, and enhances learning outcomes across all levels of study.

1.2.6. *Enhance quality of learning and teaching*

There are (03) three key characteristics, which are required to produce best learning and quality teaching by using ICT. 1. Autonomy, 2. Capability and 3. Creativity [3]. In autonomy, students improve their learning by using ICT. By this, the students become actually more capable, as they work by themselves and also work with teams all around the world. After implementing ICT, most of the time, teachers assign some tasks to the students to accomplish with peers or groups to make the students ready to work in groups and teams for their professional exposure. By using ICT, collaborative learning gives the students new opportunities to establish new knowledge. Similarly, it gives more confidence to the students in order to enjoy risks and gain knowledge from their own lapses. On the other hand, the educators / teachers design the teaching material at their own by using ICT. It gives them complete control over the course contents, which is not possible in traditional class [24]. Capability refers to the students' ability to implement and transfer the knowledge to others in effective and efficient manners by the help of ICT. For instance, students are being asked to carry out the practice of pronunciation in a language class and it requires an online dictionary, which also produce audio to make the pronunciation better. This dictionary will not only help them to make their pronunciation better, but also the meaning and definition as well. To play / use this kind of dictionary, the students must be aware that which internet browser is needed to play that dictionary properly. On the other hand, they have to select the best dictionary among hundreds of online dictionaries to fulfill their requirements. Similarly, they also need software, which can record their voice to listen their pronunciations so that it can be improved and it also needs the best recording software. In whole, it is a complete full of knowledge activity, which enhance the capability of student in different dimensions. Creativity of the students may be enhanced by the help of ICT, as ICT provides new tools of multimedia, games, smart LEDs, etc, which helps to enhance the creativity of the users in different manners [9,10]. If we generalize the whole scenario, then we can say that these three characteristics enhance the learning and teaching capabilities and quality.

1.2.7. *Facilitate the teacher by give access to the course content*

It is observed that the teachers can play their role to integrate the technology by using ICT in learning phenomenon [25]. If the teachers are supported by the institution in terms of resources, infrastructure, technological support and the confidence from management to develop the ICT class, then the class will be more appropriate for learning. In this situation teachers will be held responsible for modifying the course contents to fulfill the new requirements, which will definitely help the students to learn the things in better way.

We can sum up with the opinion that, ICT has created a boom in the students' learning and now they are not limited with the course contents, but they actually explore and think beyond the limits to get more and more knowledge and exposure [26]. ICT has created a new dimension under the relationship between learning and teaching.

The findings shows that ICT has change the entire way of traditional teaching methods [25]. Now teachers use new methodologies to make their students more knowledgeable by using ICT. They design new assignments for the student to give them variety of exposure of the real world natural phenomenon, which helps the students to get the idea clearer regarding the field of study. Specially, when we talk about higher education, where students are supposed to go for research work or novelty in already existing areas of studies, then ICT enables them to have collaborative efforts all around the world. They meet the researcher of the same field to get more clarity and possible solutions. This also helps them to share their problems with other experts by using ICT.

Though, ICT has various advantages and proved its importance in every field of life especially in education, but it is not much easy to implement ICT everywhere because various challenges, which are discussed next section.

2. Challenges for ICT in Education

As discussed in previous section that there are lots of advantages of ICT especially in education, some of the challenges, which are associated with ICT, are being faced while implementing or adopting it. Fedrick [8] in his research depicts that the main challenges, which are allied with ICT are the special needs,

mobility and anxiety due to standardized test results. Looking for the solution of such challenges, [15] found that more authentic problem-based and group-based learning environment will cope up this challenge. He also pointed out some other challenges, which are associated with students. Such as lack of technical skills, that will create a big hurdle to access ICT in class environment. Lack of technical assistance, No feedback in time, lack of interaction with other students and teachers are some other challenges [27]. That's why; the author suggested some strategies, which will be helpful to cope up such challenges and will make smooth learning process. The suggestions are orientation, training and induction for the students. He also emphasized on the significance of instructor availability and better administration. He also focused on online conferencing facility and podcasting [28]. In general, he talked about infrastructure, capacity building, policy, curriculum development, and government support to minimize the challenges and to enhance the usefulness of ICT in education. Similarly, another way to cope up such challenges is to improve the technical skills, which can help in learning at ICT platform [29].

If we look in broader sense, than challenges does not only belong to the students, but also associated with teachers as well and discussed in literature. Such challenges include:

- Emphasis on technical skills instead of course contents
- Extra burden to make the results better at national level
- Lack of encouragement and recognition from the management for effective and timely usage of ICT
- Lack of training and development practices for ICT
- Lack of possible promotions for ICT adoption in classes
- Lack in clarity of goals for using ICT in educational institutions
- Lack of pedagogical support and instructor collaboration and also lack of appropriate cooperation from inexperienced teachers
- Not enough time to integrate ICT or to be expert in new software during class period
- Not enough skills to manage technical and teaching materials
- Lack of software expertise and habitual methods for conceptualizing that what, how and why students should be taught
- Lack of experience and knowledge for using ICT in education
- Lack of related technological knowledge and how to associate that knowledge with present pedagogical contents to assist students' learning
- Technical issues related to classroom
- Huge number of students in class
- Lack of financial and technical assistance

As the challenges were observed, the solution also proposed by the researchers to cope with them. Such strategies or solutions are covered in literature. As per the literature, educational institutions are supposed to:

- Provide benefits to the instructors, who are available online to provide technological training to the teachers
- Supplement the course contents to meet the technological needs
- Give space to the teachers so that they can design the course contents to meet the technological need
- Offer continuous, timely and result oriented training to enhance ICT skills, which will make the teacher able to manage class based on ICT
- Support constructive attitudes regarding importance of combining ICT into instruction
- Impart technical trainings coupled with technology to enhance teachers' capabilities in terms of technical skills, and provide technical assistance if required
- Carry the collaborations with technological institutions, which will support the teachers to exchange efficient technological experiences and activities
- Arrange workshops, which will help teachers to replicate the result oriented methodologies for technological assembling into practice and reveal the problems relate to it

ICT should not be used just to help in teaching methodologies, but it should play its role more than that. Teachers are not supposed to implement ICT just to help in traditional methodology of teaching, but it should be adapted with respect to student-centered approach that how ICT will be used to combine the class activities to encourage students' learning [31]. It actually emphasizes that a teacher is required to implement ICT to launch some artistic and productive methods and beneficial practices with result

oriented lessons [30]. It is also suggested that the teacher must be open minded to integrate the ICT in classes. It is essential that teachers improve their teaching skills in order to adopt new teaching methodologies by implementing new tools of technology to in support of teaching, but it is observed that teachers exercise ICT more often just for preparation of their teaching material instead of upgrade their critical thinking [31]. Similarly, it is also found that teachers apply ICT just to support the present teaching methods but not with regards to student-centered approach of learning [32]. As per the authors, it happens due to lack of clearer objectives of using ICT. If the objectives are clearly mentioned and described to the teachers, then it will be more beneficial to apply ICT in order to enhance the teaching mechanisms and approach will be student-centered. Further, it is found that the teachers at initial level do not possess enough knowledge of ICT to use technology based classes. Even they do not express suitable methods to integrate ICT within the course contents [33]. That's why; it is recommended that proper trainings should be initiated to train the teachers at initial level, which will help them to design their curricular under the light of technological needs. Similarly, it is also suggested that the researchers associated with ICT should produce the examples that how teachers achieve effective and result oriented technological integration to accomplish pedagogical requirements and how to fulfill them. This will help the teachers to cope up with their difficulties faced during their practice.

In supplement to al above challenges associated with students and teachers in accordance with the use of ICT, some other challenges also exist, which are related to management and ICT infrastructure. Such challenges are discussed in literature, which include:

- The management focuses on quantity instead of quality in terms of course contents and the exam scores instead of ICT usage.
- Lack of proper support from the administration for the better usage of ICT.
- The management focuses on improvement of test scores, which diverts the concentration from ICT usage to involve students in critical thinking practices.
- Lacking in selection of proper course content and programs.
- Lacking in establishing proper infrastructure for ICT, such as software, hardware and materials.

To cope up with these challenges, the researcher recommended that management is supposed to provide the proper technological access. On the other hand, the management should involve the teachers in planning and policy making activities related to implementation and usage of ICT in classes. Lim carried out a qualitative research to assess the efficient and inefficient ICT usage in educational institutions regarding provision of solutions [34]. The findings of his research revealed that the establishment of well-organized ICT based class depends upon timely accessibility of ICT tools, the standardized educational rules and regulations, appropriate allocation of technical staff among teachers, students and teaching assistants. He emphasized that by focusing on such elements, students will be engaged in critical thinking process. The existing literature is reviewed to point out the key elements in order to make able the teachers either pre-service or in-service to implement ICT as an important pedagogical tool [35]. It was suggested that the management of educational institutions should ask the teachers to support the significant impact in terms of student-centered and technology-based instruction to enhance the exam results for standardized tests. For example, educational institutions can present opportunities for initial level teachers to study various types of models and example, which can be applied for students in real environment. Institutions are supposed to facilitate pre-service teachers in order to understand the problems, which are being faced by the teachers while using ICT in classes and design best strategies to address such problems. It is mandatory to make the vision clear for using technology in order to get the best result by using technology to enhance the learning process. It is also an important factor that while designing a pedagogical model, it should be focused that there is a strong relation between application and theory, which helps to overcome the problems and challenges which are being faced in technological integration [30]. It is also observed that detailed knowledge of using hardware and software related to ICT is an intrinsic ingredient for planning the curriculum using ICT [10]. Training and development for the staff and teachers is very important to support course contents using ICT.

3. Internet of Things (IOT)

At the end of 1990s, MIT Auto-ID proposed a new term "IoT", which was originated from the needs of logistics. It was pointed out that we are going towards "ubiquitous network society", which incorporates

that everything and object of the world is networked and connected with each other. In far future, everything from pin to plane will become the part of communication system and today's traditional internet will lead towards tomorrow's IoT (Internet of Things). The term "Things" in IoT refers to each and every objects around us, whereas interconnectivity among objects will be done by extending the networking technologies, which also includes Radio Frequency Identification (RFID). IoT is nothing but actually it's not only the Internet but also referring to wireless sensor networks and mobile communication networks.

There are three main characteristics of IoT.

1. Each and every object is instrumented. It means that every object like screws, foods, cups, buttons, tables, and automobile tires can individually be accessed by a unique address with the help of embedded chip, barcode, RFID and so on.

2. There must be interconnected Autonomic terminals. It refers to the autonomic network terminals, where all instrumented objects are interconnected.

3. Pervasive services are intelligent. In extensively-interconnected network, each and every object plays its role in service flow to make the intelligent pervasive service. For instance, sensor nodes in health monitoring system are supposed to monitor the body related quantified values like temperature, pulse rate, BP level, heartbeat to get real-time data for guiding doctoral behaviors.

Therefore, we can say that the IoT covers multiple inter-disciplinary technologies like computer science, microelectronics, communication and sensor technology. For further clarity, we can divide the IoT architecture in four different layers and the layers are "object sensing", "data exchange", "information integration", and "application service". Object sensing layer deals with sensing the objects and getting data. The data exchange layer deals with transparent communication of data. The information integration layer deals with re-organizing, manipulating and fusion of indefinite information obtained from networks, and join together the indefinite information into valid knowledge. The application service layer deals with the content services for different users.

As a matter of fact, in general, there is no any sensing capability in traditional internet and it is used only for connectivity among intelligent devices. On the other hand, there is a layer called data sensing layer in IoT and has minimized the devices capabilities and also facilitate interconnectivity among dumb devices (non-intelligent devices). At the same time, it faces lots of challenges in terms of information integration, data exchange and services including the network architecture. Depending on IoT architecture, we have to study mechanism and methods for the connectivity of various heterogeneous networks. IoT architecture must be studied with the perspective of users, application developers, network providers, and service providers, offering the standards for describing various types of interfaces and protocols.

3.1. Objectives of IoT

If we compare the traditional information network with IoT, then we can say that there are three goals / objectives of IoT.

- More extensive interconnection
- More intensive information perception
- More comprehensive intelligent service.
- They are described as follows.

3.1.1. *More Extensive Interconnection*

IoT has expanded the connectivity among information equipment, like mobile phones, laptops, tablets, etc, to provide connectivity among all physical objects either intelligent or non-intelligent. There are some following characteristics of it.

Extensiveness in terms of quantity of devices. The number of connected devices will rise very quickly from billions to hundreds of billions, which will include sensors, actuators, other equipment, vehicles, devices and many more having embedded RFID.

Extensiveness in terms of device types. Networking devices are supplied power by means of direct electronic power or by batteries. The capacity of computation or communication may have variations in large scale. For example, wireless sensors are usually resource constrained devices and have very low amount of memory, power and computational capability, even some devices may not have the computation power.

Extensiveness in terms of connection mode. The networks may be wired or wireless. Similarly, there may be a single hop or multi-hop communication.

Therefore, in heterogeneous network at large scale, we have to face the challenge of highly-efficient connectivity of network elements. IoT is supposed to connect trillions of devices and objects having low computation, memory and power capabilities like RFIS and wireless sensors along with traditional devices. In these situations, IP is not able to be used for data exchange. In recent past time, some new routing techniques and data transmission are designed, which are considered as non-IP protocols. DTN (Delay-Tolerant Networking) [36], opportunistic routing, event-based routing, location-based routing and weak state routing [35] are the example of it. Furthermore, it has been observed that there will be a huge need of changing IP and non-IP protocols in IoT in future. We are supposed to research on new requirements of networking, mechanisms and connectivity models in IoT because of heterogeneous networks and diversified applications. That's why we are supposed to study the different types of network elements and their addressing models, so that the surety may be achieved in order to make compatible networking elements. It is just to meet the huge heterogeneous networking requirement for global network.

3.1.2. *More Intensive Information Perception*

In single sensor model, the sensor independently senses local atmosphere, but this model has been extended to the model of multi-sensors by IoT, which is the need of global environment.

The information: which is sensed by single sensor, may be ambiguous due to following issues.

Non-uniformity: Each kind of value related to different domains may have different data formats.

Inconsistency: Due to time-space variation, information may be inconsistent

Inaccuracy: Different sampling method may cause the inaccuracies in sensed information.

Discontinuities: Transmission capacity of dynamic networks may cause the availability of intermittent information

Incomprehensiveness: Sensors limitation may cause incomplete sensing of information.

Incompleteness: Dynamic network may cause the Partial loss of data.

Hence, this is not possible to use the information without processing. That's why; we are supposed to cope up the challenges for the efficient usage of unpredictable data, which is sensed in IoT. This unpredictable data must be processed to be converted into certain data representation so that it can be integrated to get the high level accuracy in terms of required knowledge. After that, we will be able to manage physical environment, whenever it is needed.

3.1.3. *More Comprehensive Intelligent Service*

IoT is supposed to give the comprehensive intelligent service in an environment, in which objects are fully engaged in service process, and this phenomenon will be depending when there will be intensive sensitivity of the real world and broader connectivity among the physical objects.

As we know that IoT is new Network type. It is differentiated as per its some characteristics, which include huge number of heterogeneous elements of network, diversified systematic environment, and unpredictable sensing information. Ultimately, these characteristics may cause the challenges as well. Efficient exploitation of unpredictable sensing data, efficient connectivity among huge number of heterogeneous elements of network, ad delivery of service are key challenges in diversified systematic environment. Currently, we do not have any particular solutions to cope up such challenges, so that we can persuade the development of IoT.

4. Deployment of IoT in ICT

The early sections covered the detailed discussion over the ICT, IoT and the challenges related to them while implementing these technologies. It has been discussed that ICT is considered as an essential ingredient of every field of life especially in education to gain the better result in exams and to enhance the learning process. On the other hand, IoT also proves its importance to meet the challenges of today's world in comparison with traditional networks. It has shown the great power to sense, control and manipulate the dynamic objects of the real world by large-scale connectivity among them. We can sum up this discussion with the complement that both technologies have their own significance at individual level, but what about the merging of both technologies in a single platform. It needs to be studies that if we can deploy IoT in ICT, then what benefits will be offered after its deployment. What kinds of challenges will be faced? And what can be the solutions to resolve such challenges? Once the IoT is deployed in ICT

especially in the education, this will give a great exposure and benefits to the stakeholders, either teachers, students or the management. Let's have a look over the advantages of IoT by its deployment in ICT in education.

4.1. Benefits of IoT Deployment in ICT

Though there are lots of advantages of ICT and IoT discussed individually, but if consider the deployment of IoT in ICT then we have to have a closer look over the benefits of it so that we can examine that either is it beneficial to deploy IoT in ICT especially in education, or we are already getting the same benefits through ICT. This should be study in a very careful manner, because the deployment of IoT in ICT is supposed to be an expensive experiment, as we are supposed to deploy the sensors in each and every object as per the requirement of an educational system / environment. The installation, controlling, maintenance, etc, also demand some extra technical skills, human power, check and balance and off course financial assistance. That's why; it is once again recommended that it should be kept in mind that cost must be less than the advantages while assessing the advantages of IoT in ICT and feasibility report.

The advantages of the implementing IoT in ICT especially in education are as follows.

Surveillance of the classes: It will be easy to have a look in classrooms that the resources used in ICT are being used in decent way. The students must be under observation to check their use of ICT.

Controlling of ICT resources: IoT will help to make the control easy of ICT resources. If any misuse will be sensed by the sensor, it will make the management alert.

Student' recognition: IoT in ICT will help the management and teachers in terms of making surety that only students are being authorized to be the part of class room instead of any stranger or visitor by face recognition with the help of sensors.

Security: The sensors may be deployed to sense the entrance of only authorized persons. This can be done without using any watchman over the gate of institution. The authorized persons will be given RFID embedded card which will be detected by the sensors to give them entrance.

Controlling of unauthorized devices: The will help to prohibit the unauthorized electronic devices especially in exams. Only authorized devices will be accessible.

Class management: IoT will make the management of class in easier way. The teacher is not supposed to do most of the work manually. It will be done by given electronic instructions.

The advantages of IoT in ICT especially in education are not limited to the above discussed points, but it can be more and more as per the need of the system. As we know, that the objects create their more needs by themselves after they become the part of the system, so it will be happening in a same manner in case of IoT in ICT. Such as vehicle parking, parties, ethical values, canteen, and so many things will easily be managed and controlled by IoT.

4.2. Challenges of IoT Deployment in ICT

It is obvious that once we are going to merge these technologies, we will get lots of benefits of it. But it is not as easier to run things in smooth way. Things don't be done in a way what we think or perceive. Though, the deployment of IoT in ICT especially in education is having its own advantages, but meanwhile its deployment also faces different challenges. It is a fact that all those challenges, which have been discussed in earlier section at individual level with respect to each technology, will be faced after merger because such challenges will be inherited by birth. That's why; such challenges are not being discussed again. But there are some other challenges as well, which we are supposed to face while deploying IoT in ICT. Such challenges may be divided with respect to external challenges and internal challenges. Let's have a look over external challenges.

Political instability: It is a fact that deployment of IoT is not possible without the concerns of the Government and it needs fully support at government level. But political instability may cause the hindrance in deployment of IoT in ICT.

Financial assistance: Deployment of IoT in ICT in underdevelopment countries like Pakistan is much difficult especially in terms of financial affordability. Pakistan has to face lots of challenges due to low economic growth then it will be a serious challenge to establish and deploy IoT, as it needs proper funding from the government, whereas there are lots of other issues, which need the financial assistance too.

Cultural diversification: It looks bit awkward but it's a fact that the culture is also a barrier in order to implement IoT, because people of Pakistan especially from the rural areas are not much aware of technology. So it is quite difficult for them to accept a new technology at once like IoT. For example,

Pakistani government started the biometric system in school to ensure the regular and punctual attendance of teacher and staff but in most of the schools, this system has been failed because the biometric machines have broken or not functioning, and it is found that the staff is involved in it.

Similarly there are some internal challenges, which may cause the hindrance in deployment of IoT in ICT. Such challenges are as follows.

Lack of technical staff: IoT deployment requires highly skilled technical staff, which is lacking in Pakistan, especially in rural areas. IoT in ICT demand full time skilled personnel, who should be available 24 hours to look after the whole system. But unfortunately Pakistan is lacking in this domain.

Lack of resources: Educational institutions are already running short of resources, than how it will be possible to meet the requirement of IoT deployment, which definitely needs lots of expensive resources. Because it needs a complete infrastructure, which is supposed to be built from the initial level.

Lack of speedy connection: If we have a look on Internet Service Providers (ISPs) in Pakistan, then we find that only 3 to 4 ISPs recently launched 4G service and this 4G service is not provided in the whole country, but this service is being provided only in big cities, whereas IoT needs speedy internet connectivity.

4.3. Best efforts for deployment of IoT in ICT

A well-known quotation by an intellectual is “When there is a will, there is a way”. Though, there are many challenges to be faced while deploying IoT in ICT, but it doesn’t mean that we avoid implementing the technologies. We should go for the solutions. Let’s have a look over the solutions. There must be consistency in policies with regards to technological implementation in every situation either political consistency or instability. On the other hand, there must be proper funding with respect to technological deployment. There should be handsome amount of budget for it. Similarly, it is the responsibility of the government to provide the required resources in time. If the resources are not available within the country, then such resources should be imported from abroad to meet the demands of IoT deployment. In addition, it is also the major responsibility of the government and the institution to make the people aware of newly adopted technology and its benefits in their lives. It can be happened by giving awards to them, boost in their living standards, and benefits at local level, and so on. This will attract the attention and acceptance towards the new technology and will bring a positive change in their attitude. They should be motivated by giving them some orientation and training sessions, so that they will become familiar to the technology. These efforts will definitely overcome the problems related to deployment of IoT in ICT especially in education.

5. Conclusion

Technology plays major role in the development of any country especially in economic and educational development, whereas sharing of information has become unavoidable in today’s life, where billions of people share their views and other information with each other. That’s why; ICT has become an essential ingredient of every field of life especially in education to obtain the maximum benefits from it. On the other hand, IoT is a new theme of internet, in which all the real world objects are interconnected by using embedded RFIDs or sensors and can be used to sense the physical / environmental values to monitor and control it. Both technologies have their own benefits at individual level, but these benefits may be doubled by deploying IoT in ICT especially in education. Though, there are some challenges to be faced while implementing IoT in ICT but these challenges may be coped up by applying the possible solutions and best efforts. This will make the implementation of IoT in ICT so that the development can take place in the field.

References

1. Chien, Fengsheng, et al. "The role of information and communication technology in encountering environmental degradation: proposing an SDG framework for the BRICS countries." *Technology in Society* 65 (2021): 101587."
2. Kashani, Mostafa Haghi, et al. "A systematic review of IoT in healthcare: Applications, techniques, and trends." *Journal of Network and Computer Applications* 192 (2021): 103164."
3. Goyal, Sukriti, et al. "IoT enabled technology in secured healthcare: applications, challenges and future directions." *Cognitive Internet of Medical Things for Smart Healthcare: Services and Applications* (2021): 25-48."
4. Misra, N. N., et al. "IoT, big data, and artificial intelligence in agriculture and food industry." *IEEE Internet of things Journal* 9.9 (2020): 6305-6324."
5. Laghari, Asif Ali, et al. "A review and state of art of Internet of Things (IoT)." *Archives of Computational Methods in Engineering* (2021): 1-19."
6. Ayaz, Muhammad, et al. "Internet-of-Things (IoT)-based smart agriculture: Toward making the fields talk." *IEEE access* 7 (2019): 129551-129583."
7. Selvaraj, Sureshkumar, and Suresh Sundaravaradhan. "Challenges and opportunities in IoT healthcare systems: a systematic review." *SN Applied Sciences* 2.1 (2020): 139."
8. Farahani, Bahar, Farshad Firouzi, and Markus Luecking. "The convergence of IoT and distributed ledger technologies (DLT): Opportunities, challenges, and solutions." *Journal of Network and Computer Applications* 177 (2021): 102936."
9. Gupta, Alok Kumar, and Rahul Johari. "IOT based electrical device surveillance and control system." 2019 4th international conference on internet of things: Smart innovation and usages (IoT-SIU). IEEE, 2019."
10. N. e. a. Aslam, "Securing the Road: Advancing Cybersecurity in Internet of Vehicles with Deep Learning.," *Journal of Computing & Biomedical Informatics* , (2024).
11. Khanna, Abhishek, and Sanmeet Kaur. "Internet of things (IoT), applications and challenges: a comprehensive review." *Wireless Personal Communications* 114 (2020): 1687-1762."
12. Smys, S., Abul Basar, and Haoxiang Wang. "Hybrid intrusion detection system for internet of things (IoT)." *Journal of ISMAC* 2.04 (2020): 190-199."
13. El-Hajj, Mohammed, et al. "A survey of internet of things (IoT) authentication schemes." *Sensors* 19.5 (2019): 1141."
14. Hussein, AbdelRahman H. "Internet of things (IOT): Research challenges and future applications." *International Journal of Advanced Computer Science and Applications* 10.6 (2019)."
15. Brous, Paul, Marijn Janssen, and Paulien Herder. "The dual effects of the Internet of Things (IoT): A systematic review of the benefits and risks of IoT adoption by organizations." *International Journal of Information Management* 51 (2020): 101952."
16. Poongodi, M., et al. "A measurement approach using smart-IoT based architecture for detecting the COVID-19." *Neural Processing Letters* (2021): 1-15."
17. Atlam, Hany F., and Gary B. Wills. "IoT security, privacy, safety and ethics." *Digital twin technologies and smart cities* (2020): 123-149."
18. Makhdoom, Imran, et al. "Blockchain's adoption in IoT: The challenges, and a way forward." *Journal of Network and Computer Applications* 125 (2019): 251-279."
19. Wang, Jianxin, et al. "The evolution of the Internet of Things (IoT) over the past 20 years." *Computers & Industrial Engineering* 155 (2021): 107174."
20. Valsalan, Prajoona, Tariq Ahmed Barham Baomar, and Ali Hussain Omar Baabood. "IoT based health monitoring system." *Journal of critical reviews* 7.4 (2020): 739-743."
21. Sobin, C. C. "A survey on architecture, protocols and challenges in IoT." *Wireless Personal Communications* 112.3 (2020): 1383-1429."
22. Tawalbeh, Lo'ai, et al. "IoT Privacy and security: Challenges and solutions." *Applied Sciences* 10.12 (2020): 4102."
23. Khan, Muhammad Adnan. "Challenges facing the application of IoT in medicine and healthcare." *International Journal of Computations, Information and Manufacturing (IJCIM)* 1.1 (2021)."
24. Hossein Motlagh, Naser, et al. "Internet of Things (IoT) and the energy sector." *Energies* 13.2 (2020): 494."
25. Stoyanova, Maria, et al. "A survey on the internet of things (IoT) forensics: challenges, approaches, and open issues." *IEEE Communications Surveys & Tutorials* 22.2 (2020): 1191-1221."

26. Singh, Ravi Pratap, et al. "Internet of things (IoT) applications to fight against COVID-19 pandemic." *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* 14.4 (2020): 521-524."
27. Adi, Erwin, et al. "Machine learning and data analytics for the IoT." *Neural computing and applications* 32 (2020): 16205-16233."
28. Srinivasan, C. R., et al. "A review on the different types of Internet of Things (IoT)." *Journal of Advanced Research in Dynamical and Control Systems* 11.1 (2019): 154-158."
29. Balaji, Subramanian, Karan Nathani, and Rathnasamy Santhakumar. "IoT technology, applications and challenges: a contemporary survey." *Wireless personal communications* 108 (2019): 363-388."
30. Babun, Leonardo, et al. "A survey on IoT platforms: Communication, security, and privacy perspectives." *Computer Networks* 192 (2021): 108040."
31. Farooq, Muhammad Shoaib, et al. "Role of IoT technology in agriculture: A systematic literature review." *Electronics* 9.2 (2020): 319."
32. Alshehri, Fatima, and Ghulam Muhammad. "A comprehensive survey of the Internet of Things (IoT) and AI-based smart healthcare." *IEEE Access* 9 (2020): 3660-3678."
33. Kumar, Krishna, Narendra Kumar, and Rachna Shah. "Role of IoT to avoid spreading of COVID-19." *International Journal of Intelligent Networks* 1 (2020): 32-35."
34. Aboubakar, Moussa, Mounir Kellil, and Pierre Roux. "A review of IoT network management: Current status and perspectives." *Journal of King Saud University-Computer and Information Sciences* (2021)."
35. Gulati, Kamal, et al. "A review paper on wireless sensor network techniques in Internet of Things (IoT)." *Materials Today: Proceedings* 51 (2022): 161-165."
36. Tahsien, Syeda Manjia, Hadis Karimipour, and Petros Spachos. "Machine learning based solutions for security of Internet of Things (IoT): A survey." *Journal of Network and Computer Applications* 161 (2020): 102630."
37. Dachyar, M., Teuku Yuri M. Zagloel, and L. Ranjaliba Saragih. "Knowledge growth and development: internet of things (IoT) research, 2006–2018." *Heliyon* 5.8 (2019): e02264."
38. Chanal, Poornima M., and Mahabaleshwar S. Kakkasageri. "Security and privacy in IOT: a survey." *Wireless Personal Communications* 115 (2020): 1667-1693."
39. Guo, Fengxian, et al. "Enabling massive IoT toward 6G: A comprehensive survey." *IEEE Internet of Things Journal* 8.15 (2021): 11891-11915."
40. Islam, Md Milon, Ashikur Rahaman, and Md Rashedul Islam. "Development of smart healthcare monitoring system in IoT environment." *SN computer science* 1 (2020): 1-11."
41. Ghosh, Arka, David John Edwards, and M. Reza Hosseini. "Patterns and trends in Internet of Things (IoT) research: future applications in the construction industry." *Engineering, construction and architectural management* 28.2 (2021): 457-481."
42. Otoom, Mwaffaq, et al. "An IoT-based framework for early identification and monitoring of COVID-19 cases." *Biomedical signal processing and control* 62 (2020): 102149."
43. Chowdhury, Mostafa Zaman, et al. "6G wireless communication systems: Applications, requirements, technologies, challenges, and research directions." *IEEE Open Journal of the Communications Society* 1 (2020): 957-975."
44. M. M. e. a. Rafiqee, ""Implementation of Efficient Deep Fake Detection Technique on Videos Dataset Using Deep Learning Method.,"" *Journal of Computing & Biomedical Informatics* , vol. 5.01 , pp. 345-357., (2023): .