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PAPER

An Analytical Study on the Implementation of a Healthcare App to Assist People with Disabilities Using Cloud Computing and IoT

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ABSTRACT

This study targets a group of people who require care, that is, people with special needs. The significance of this study lies in addressing the main problem that this group suffers from, which is the lack of awareness and information that leads to the acceptance of that group in society. This work aims to create a mobile application that contributes to spreading knowledge among people with special needs and enhancing their skills to help them become accepted by community members. This application supports people with special needs with training resources, education, suitable jobs, and other services helping them in developing their experiences and knowledge to be active in society. In addition, an evaluation questionnaire has been developed to collect data from both the private and public sectors to classify the building blocks necessary for KSA to incorporate the Internet of Things (IoT) and cloud computing into the healthcare sector. As a result, most respondents acknowledge the importance of a streamlined data-gathering process, the IoT, and cloud-based computing to meet their healthcare needs. Lastly, six main blocks for checking suppliers and the public to accept IoT and cloud healthcare applications are then acknowledged in this paper.

KEYWORDS

cloud computing, healthcare application, special needs, IoT

1 INTRODUCTION

People with special needs is a broad term that starts from people of all ages and genders with slight impairments in development, sense, or perception to people with obvious physical, mental, or psychological disabilities. The environment surrounding people with disabilities, regardless of the type of disability, plays a vital role in

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the positive or negative growth of disability, morale, and psychological comfort. There are mainly two environments: a positive environment, which is the supportive and inclusive for the disabled individual within it, and a negative environment, which is the environment whose members do not accept the existence of a disabled individual among them.

Our main problem in this study is this negative environment. To solve this problem, we developed a mobile application for supporting people with special needs by offering awareness and information about the social needs of those people to convert that negative environment into a positive one. This action will support people with special needs psychologically and physically and help make them effective in society by enabling them to practice their role in life like normal people. The proposed application offers learning and training services for people with special needs in addition to some simple jobs specialized to enable and support them in society.

In this study, we adopt a complete approach to analyzing healthcare Internet of Things (IoT) and cloud computing to discuss the limitations mentioned previously. Many components of the IoT and cloud computing are being applied to the healthcare industry. These include the standard IoT and cloud computing architecture, standard phases that permit healthcare requests to link the IoT, and cloud computing support. Similarly, we systematically linked concepts, demands, infrastructure, and initiatives related to healthcare's integration with the IoT and the cloud [1]. The key objectives of this research are defined as follows:

- Individuals with special needs will get great benefits through using this application, for example, training courses, suitable jobs, and other features.
- Normal individuals will change their view of people with special needs after using this application, which is a good means to make those people active and productive.
- This application will enable connections and deals between people with special needs and normal people.
- It will enable supporting people with special needs with digital resources and suitable opportunities to get a job. It also helps in canceling the negative view that some members of society may have of people with special needs.
- It will save money for families who have people with special needs.
- It will contribute to increasing the workforce in the society.
- It will enhance the trust of people with special needs and spread awareness in society about the importance of those people.

Figure 1 shows the theoretical IoT for permitting healthcare. Associated objects (IoT) gather the health information of patients (people with special needs) and then direct it toward the cloud (reserved or open). Individuals' facts are examined to grow into valuable condition evidence.

Valuable health facts are accessible to caregivers (of people with special needs) as a method of information or observing a graphic user interface. Frequent IoT examinations and revisions are completed for the healthcare sector from several standpoints like practical and technological viewpoints, a survey of existing IoT-allowed healthcare requests, and the outline for assuming IoT in the healthcare sector [2]. The present study targets people with special needs in KSA as well as other countries. The resulting mobile app will be available to any person in the world, so it will be reliable, flexible, and easy to use.

Fig. 1. The concept of IoT permitted healthcare [2]

2 IoT AND MOBILE HEALTHCARE APPS FOR DISABILITY

Healthcare digitalization has become a remarkable point of interest over the last few years due to its numerous benefits. Patients need to have their behavior and health status frequently monitored to be able to notify doctors and relatives of either critical threats or health improvement. Such strict and constant monitoring cannot be fully established and checked by caregivers or nurses [3]. The IoT serves as a very convenient and effective way to deal with such an issue. IoT is equipped with several computing machines that effortlessly associate and connect to accomplish a requested task. This type of digital intelligence is vastly needed in mobile healthcare services. These minute devices that track the patient's health status can be either wearable, portable, or implantable. The *Internet of Healthcare Things* is the name given to the implementation of IoT that focuses on healthcare services. The modern digital approach of IoT has developed health management systems and enhanced their competence [4]. Yet, many challenges and obstacles lie ahead. Medical care apps are mainly constrained to managing and handling health maintenance services that have various rules, medical protocols, distinct efficiency, and diverse working standards. Therefore, it is highly essential to draw a distinct borderline between the tangible operational appliances and the application that provides all these diverse services and transparently manages all types of challenges; this borderline is known as the "middleware" [5].

As reported by the WHO, more than 15% of the human race has some kind of physical impairment. Handicapped or impaired individuals require a 24-hour care service. This amount of needed attention demands a lot of human effort and time. The notable developments in the digital era have led to many high-tech innovations that have also improved the living standards for people with disabilities [6]. Many individuals that have a physical impairment in KSA also have a few chronic diseases which intensify the impact of inability on their wellbeing and performance. Additionally, there is developing proof that disabled people face negative significant distinctions in getting access to healthcare services, especially preventive medicine and other medical care services that can alleviate permanent diseases [7]. Mobile healthcare (M-health) is being promoted as a significant modern tool for the medical management of chronic diseases. M-health can be generally identified as a significant tool for healthcare service delivery via mobile communication devices. More particularly, M-health indicates the healthcare delivery, facilitation

guide, and linking of health and clinical data using mobile digital communication and interactive media technologies—as well as tablets, cell phones, and mobile infrastructure [8, 9].

IoT is a modern tool designed to add highly significant and promising aspects to the area of IT. IoT intends to virtually link and associate everything on the Internet. Researchers have represented an overview of the currently introduced innovations of IoT. Moreover, IoT can be considered a potential aspect in providing possible solutions for people with disabilities. With the empowered solutions provided by IoT, disabled people or elderly citizens can experience a better quality of life and be more involved in society [10]. Within the authentic model of IoT, Internet access is achieved by sensor-based technologies like RFID (Radio Frequency Identification). Wireless sensor networking and RFID technology are IoT's major supporting operation technology. Nonetheless, modern embedded computers like Galileo and Raspberry Pi may also be used in IoT main infrastructure. IoT allows modern solutions to easily connect people, the environment around us, and other significant things. Accordingly, IoT has established several possible solutions that can aid people with disabilities by handling their roles and tasks with much greater ease. In this research, the authors aim to present solutions that include IoT technology that will aid and support disabled people to remotely connect with healthcare providers and ask for help and needed attention through short messages.

3 RELATED WORK AND APPS

Nowadays, only limited information is available about the accessibility of disabled people to the M-health apps market even though they may have some of the chronic diseases picked out by these apps. The purpose of this paper is to describe the preliminary efforts and measures taken to determine the present situation of M-health for people with disabilities. We have inspected and reviewed recent literature and authentic online sources to identify the ongoing status of M-health apps that mainly target disabled people and the involvement of people with impairment in the evaluation reviews of M-health apps that target both disabled people and other citizens. Moreover, we collected data from disabled people in KSA regarding usage rate and experiences of healthcare services systems and suggestions for further developments.

In [1], the researchers presented a questionnaire to evaluate, analyze, and determine the most recent IoT aspects and tools, applications, and trends regarding health services, as well as research of recently developed IoT systems and healthcare applications based on cloud computing. The authors acknowledged the fact that modern digital technologies like ambient assisted living, cloud computing, wearables, and big data are implemented in the industry of healthcare services and identify diverse IoT, Internet health adjustments, and policies around the world to identify IoT's continuous development and cloud computing within the health industry. The authors also provided a comprehensive review of the current privacy and security infrastructure of the IoT, including security setups, possible challenges, and threats from a healthcare perspective. In addition, the paper analyzed some of the previous security-wise models to handle and treat security risks and introduced recent trends, identified potentials, and challenges for further development of IoT-based systems.

The authors in [11] created a system for school, university, and graduate students. They employed fuzzy logic to express system inputs, outputs, and rules.

A career and educational assistance app for a digital revolution in career counseling is presented in this research. The suggested system used interactive technologies to assist students in choosing universities that fit their educational talents, and experiences. Mobile Cloud Computing, a new future technology for wireless services, emerged from the growing expansion of mobile devices and mobile-based systems and cloud computing [12]. The authors in [13] investigated the potential for creating a portable system to aid the deaf and other persons in communicating and learning via portable gadgets. Evidence from a pedagogical evaluation of a prototype system has shown that the mobile app is remembered and easily learned by its users because of its recognition-based interface. The author in [14] constructed a model by empirically studying the characteristics positively impacting behavioral intention to embrace IoT and IoT usage and adoption in higher education institutions. This study's findings matched earlier research. The study also found that social impact positively affects behavioral intentions, suggesting that people utilize new technology because others do [15].

In [33], the researchers proposed a system to support disabled people and elder citizens who face some difficulties in speaking loudly or moving properly to ease the controlling process of the devices. The suggested structure is mainly built on Raspberry Pi, which is an IoT framework. The suggested plan helps in communication and sending significant text messages to health caregivers in medical care units in which patients face some difficulties in speaking. They can easily inform the staff about their needs through simple clicks on their smartphones. They can also control the appliances by touching these buttons on their phones. The elderly may easily play the pre-recorded audio message through the Internet if Raspberry Pi is provided with a public IP address.

3.1 Related apps

People with special needs need to develop their skills and abilities to be active in the community, and the suggested application works as a supporter of those people to achieve that goal. There are other apps related to this goal as well.

a) ***Divyang App*:** This system is a mobile application that aims to bring physically challenged persons on a common platform, to interact and exchange ideas that support them through their daily life [16]. This app offers the opportunity for people with special needs to be active in the mainstream of the global society using cloud computing. It targets all people with special needs all over the world to make them better. It is a free application [17].
b) ***Special Needs Children App*:** This application supports children with special needs in addition to their parents regarding how they deal with them. Also, it provides a good means for developing the skills and mental abilities of those children with special needs [18]. This app focuses on the following fields: awareness information, medical sector, behavioral sector, developmental sector, learning sector, and mental health sector. It is designed for children's needs [19].
c) ***Inclu App*:** This app was developed for Brazilian military college educators and students to help them better understand the range of needs addressed by Special Education programs for students with a variety of disabilities (including but not limited to hearing loss, vision loss, intellectual disability, autism spectrum disorder, and physical disability) [20]. The app's features include resources for educators and students on how best to support a peer or classmate with special needs

so that they can fully participate in school and community life. It was made especially for youngsters and kids [21].

d) ***Accessibility Map App*:** This program tells disabled individuals where they can find accessible locations in the community they live in [22]. This is the first program of its kind, and the first map of its kind, to be built on information gathered from people living in Russian towns [23, 24].

4 METHODOLOGY

We have used three approaches to collect statistics about the proposed mobile healthcare application for people with special needs. In the first approach, we searched for peer-reviewed journals on portable health and people with disabilities. In the second approach, we examined the Internet for recent works and network properties associated with a mobile health application. We checked statistics from governmental, commercial, or trade sources. In the third approach, we had an online review to control the present procedure and knowledge of mobile health applications. Questionnaires were conducted among people with special needs, such as expressive comprehensive range of visualization, hearing, dexterity/flexibility, knowledge/mental ability, and statement problems.

5 PROPOSED APPLICATION ANALYSIS AND DESIGN

The analysis of the Global Healthcare Internet of Things (IoT) Market Research presents two forecasts for the period 2019–2021. A study from market experts and news sources [25] has highlighted the healthcare industry's growing interest in leveraging advanced health technologies, including IoT-enabled applications, to enhance its outcomes. The primary aim of enhancing healthcare for individuals with specific needs is to significantly reduce costs and vastly improve healthcare services. Consequently, IoT and cloud computing are poised to make healthcare services more accurate and accessible. The concept of IoT-enabled healthcare is being particularly harnessed for the advancement of wearable technologies and digital healthcare solutions [26]. It is proposed that by integrating wearable devices into the IoT framework, a range of health services can be provided through telemedicine, enabling self-diagnosis monitoring. This transformation is expected to greatly impact risk management, which is a crucial component of IoT implementation [27]. Moreover, it is emphasized that IoT-enabled healthcare is expected to bring fundamental changes, benefiting not only individuals with special needs but also revolutionizing the entire healthcare sector's approach to personalized health services. The proposed application has outlined several objectives for IoT-enabled healthcare, including ensuring the availability of services anytime and anywhere, reducing hospitalization rates, enhancing health and healthcare services, providing highly accurate and efficient monitoring systems, and minimizing overall healthcare costs. The subsequent models are detailed below.

5.1 The flow of originations (FOO) model

FOO is a technique designed to connect confident networks within the community of individuals with special needs. It serves as a model aimed at elucidating the

process, rationale, and the extent to which innovative ideas and novel abilities are nurtured within this group. The FOO model does not manifest instantaneously; rather, it evolves through a six-phase outcome procedure over a certain period. The following outlines the sequential progression of these phases:

- Awareness: the acceptable confirmation of an improvement that has been shown to stimulate different people for approval.
- Influence: how tough the assessment of special needs supports people's initiatives and the individual's concern.
- Result: whether the individual agrees or disagrees with the service of commencing after considering its pros and cons.
- Execution: if the individual with special needs decides to stop accepting the improvement after evaluating its usefulness and finding that no other achievement has occurred, or if they decide to keep accepting it.
- Confirmation: the outcome that determines whether or not an individual must continue to follow the routine for development.
- Maintenance: updating the model regardless of whether or not the person does it regularly.

The FOO model should usually be used on the investigation mechanism to define how social systems deal with people with special needs, support new inventive concepts and tools, deliver an outline to the extent of the success of a package, movement, or plan, encourage or depress the implementation of an improvement, and clarify the achievement of or the disappointment from an invention [28]. We have used the FOO model in our healthcare research paper for IoT and cloud computing support [29].

5.2 Knowledge Getting Model (KGM)

We have changed the Theory of Reasoned Action and have established the statistics scheme model, the Knowledge Getting Model (KGM) [30, 31]. This model shows how a new skill is recognized and recycled by consumers. We found that the "key driver of KGM is to offer a source for finding the influence of exterior issues on interior views, approaches, and plans". An individual's plan of consuming a new scheme is designed for people with special needs by three specific views as follows:

- Observed Convenience (OC): This is the step in which the individual with special needs trusts the new healthcare organization that will improve his/her health performance.
- Observed Comfort of the Procedure (OCP): At this point when the individuals with special needs consider the new IoT and cloud computing techniques, the healthcare organization will do the work easily.
- Observed Implementation of Procedure (OIP): At this point, the individual with special needs rests or carries on implementing the new IoT and cloud computing techniques that healthcare organizations have assessed, and no other problem will happen.

A KGM has been used in this research paper to realize the new (IoT and cloud computing) technology or healthcare organization recognized by individuals with

special needs and check their performance in new technology or scheme [32]. We have used the KGM to observe the hospitals' interactive plan to customize the cloud computing and IoT applications [33].

5.3 Survey questionnaire analysis and design

The following sections display a dissimilar gathering of healthcare applications created on IoT and cloud computing. We have deliberated distinct as well as numerous restriction requests. It has been constructed on current IoT and cloud computing that healthcare examination has been used on the specific disease of people with special needs and technology like wheelchair management [34, 35], camera devices, accelerometer devices, and power sensors [36, 37].

The main step in this paper is that the needed data is collected using a questionnaire. To review the outcomes from Query 1 to Query 5 as shown in Table 1, it has been displayed that 74.7% of participants have information about special needs, 54.2% know how to react to special needs, and 98.8% agree that we have to support people with special needs to develop their skills [38]. In addition, 96% agree to find an application that supports people with special needs, and 95% agree to supply the supporters with an electronic tool to help a person with special needs (see Figure 2). The IoT and cloud computing have been combined to develop tools that match users' skills and abilities [39, 40].

Table 1. Survey questionnaire analysis and design

Questions	Answers	Child Age	Young Age	Respondents (84)
1. Do you have information about special needs?	Yes, I know what it is.	0.4%	60%	92
	Yes, but it is not clear what it is about.	0.3%	14%	
	No, I do not know about it.	0.3%	25%	
2. Do you know how we can react to special needs?	Yes, I do.	0.2%	54%	93
	No, I do not.	0.8%	45%	
3. Do you agree that we have to support people with special needs to develop their skills?	I agree.	0.8%	98%	92
	I do not agree.	0.2%	1%	
4. Do you agree to find an application that supports people with special needs?	I agree.	0.3%	96%	91
	I do not agree.	0.7%	3%	
5. Do you agree to supply supporters with an electronic tool to help a person with special needs?	I agree.	0.2%	95%	93
	I do not agree.	0.8%	4%	

According to Table 2, the results of questions 6, 7, 8, 9, and 10 have presented that 54.2% of respondents have approved that IoT-permitted healthcare is original knowledge, but 95.2% have been consuming wearable devices, and 97.5% are willing to use wearable devices on the IoT for healthcare requests. Moreover, 92.8% identified that wearable devices have an IoT scheme, and 92.2% and 95.2% believe that governmental and private institutions, respectively, should adopt IoT for healthcare requests. We will not standardize the results, even though IoT-enabled healthcare is acknowledged as an innovative concept. However, it has not yet progressed to attain full validation [41].

Table 2. Survey questionnaire analysis and design (cont.)

Questions	Answers	Child Age	Young Age	Response
6. Do you distinguish IoT and cloud in healthcare like special needs distant patient checking, behavior modification, and original knowledge?	Yes, I know what it is.	0.2%	54%	93
	Not really.	0.5%	25%	
	No, it is not.	0.3%	20%	
7. Do you consume any wearable IoT and cloud devices such as wristbands for special needs?	Yes, I do.	0.2	95%	93
	No, I do not.	0.8%	4%	
8. Are you willing to use wearable IoT and cloud devices such as wristbands for remote monitoring of the behavior modification of patients with special needs?	Yes, it is good.	0.3%	70%	79
	I will consider it useful.	0.2%	27%	
	No, I will not.	0.5%	2%	
9. Do you consider that IoT and cloud healthcare operators are the prospects of digital health?	Yes, I do.	0.8%	92%	92
	No, I do not.	0.2%	7%	
10. Which of the following should exert effort toward the approval of IoT and cloud in the healthcare of people with special needs? (You may select more than one)	Government	0.2%	92%	93
	Private companies	0.2%	95%	
	Hospitals	0.8%	7%	
	Health service providers (operators)	0.8%	4%	

6 RESULTS AND DISCUSSION

A literature review was conducted to categorize the barriers faced by businesses in adopting healthcare IoT. The review covered studies conducted between September 1, 2019, and September 15, 2020, focusing on establishing the challenges faced by various nations, including Saudi Arabia (KSA). The gathered data from this review, along with the analysis of existing literature, were carried out based on the objectives outlined in section 4. The survey questionnaire was completed by a total of 84 participants who volunteered for this study.

Upon reviewing the reports and analyzing the survey results, significant challenges have emerged, as indicated in Table 3. These challenges are crucial to address as they need to be tackled as a priority. Once these challenges are effectively addressed, it will pave the way for both providers and the community to fully embrace and leverage IoT and cloud technologies within the healthcare sector [42, 43, 44]:

- Organizational Structure: This encompasses intricate skills required for managing extensive strategic operations and handling the connectivity and capacity aspects of cloud infrastructure.
- Management of Comprehensive Healthcare Data: Proficiency has been achieved in processing and transforming raw health data into valuable insights.
- Skill Shortage in the IoT Landscape: The emphasis has been on cultivating skilled professionals. The lack of right personnel has hindered the adoption of IoT and cloud technologies in the healthcare sector.
- Regulatory Measures for IoT and Cloud-Enabled Healthcare: This involves establishing supervisory controls for maintaining the quality and security of IoT and cloud devices and ensuring compliance with regulations set by governing bodies.

- Patient and User Data Security: The focus has been on preventing the leakage of health-related data and maintaining patient and user privacy.
- Enhanced Reliability in IoT and Cloud Expansion: A reliability model has been implemented to establish a framework for ensuring consistency and effective management of the innovative aspects of IoT research activities.

Table 3. Survey results for blocks of public acceptance

Questions	Answers	Child Age	Young Age	Response
1. IoT and cloud-enabled healthcare devices or wearable devices aim to gather facts about your condition like heartbeats and blood pressure and then send them to the health check supplier via the Internet. What are the concerns for monitoring the behavior of patients with special needs remotely?	Confidentiality of biological facts.	0.7%	74%	92
	Not really but suspicious of the utility of biological facts.	0.3%	15%	
	No, I do not have any concern.	0.3%	10%	
2. Many studies have related the numerous forms of IoT and cloud devices to violence. Which of the following do you agree can moderate or reject the possibility of security concerns?	Yes, the government and private corporations produce vulnerability free of IoT devices.	0.2%	54%	79
	Yes, the government should develop security for these patients and gather the facts from health check suppliers.	0.2%	54%	
	Private corporations are responsible and accountable for the security and privacy of these patients.	0.3%	44%	
	No requests are needed to recover this condition.	0.5%	1%	
3. Do you have faith in the innovative technology, IoT, that can support the patient's special needs to prevent diseases and reduce hospital entry?	Yes, it is trustable.	0.2%	98%	93
	No, I do not.	0.8%	1%	
4. Are you ready to accept the innovative technology of IoT and cloud healthcare and monitoring?	Yes, it is adaptable.	0.3%	96%	91
	No, I do not think so.	0.7%	3%	
5. Do you agree to supply supporters with an electronic tool to help a person with special needs?	I agree.	0.2%	95%	93
	I do not agree.	0.8%	4%	

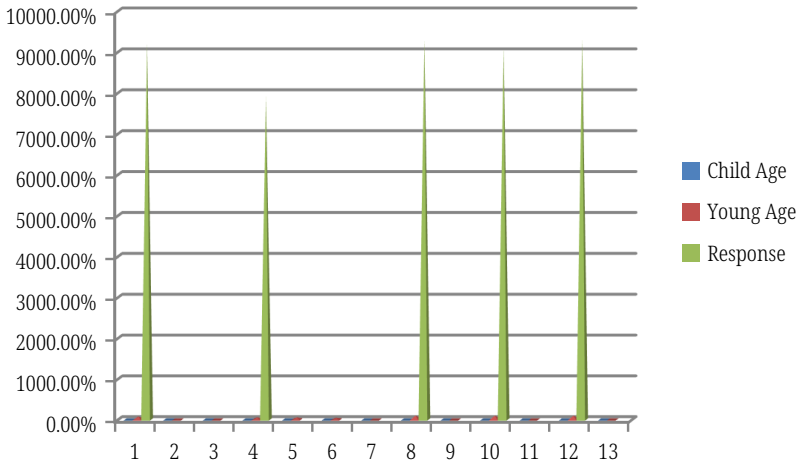

Fig. 2. Survey results for blocks of public acceptance

Table 4. Summary of the discussion of respondents' results for private and public acceptance (IoT and cloud)

Questions	Answer (Yes)	Answer (No)	Respondents (84)
1. Do you have information about special needs?	74.7%	26.3%	92
2. Do you know how we can react to special needs?	54.2%	45.8%	93
3. Do you agree that we have to support people with special needs to develop their skills?	98.8%	1.2%	92
4. Do you agree that we have to allow people with special needs to be active in the community?	97.5%	2.5%	79
5. Do you agree to find an application that supports people with special needs?	96.3%	3.7%	91
6. Do you agree to supply them with an electronic tool to write their private needs to be reviewed by supporters?	95.2%	4.8%	93
7. Do you agree to supply supporters with an electronic tool to help a person with special needs?	92.8%	7.2%	93

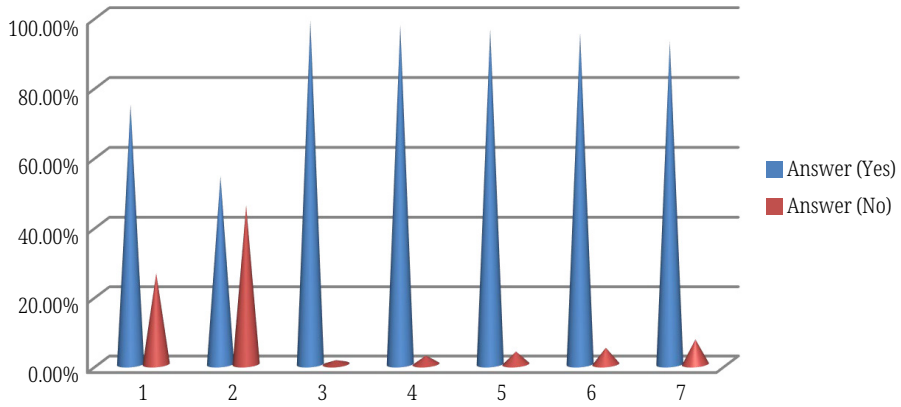

Fig. 3. Result of the questionnaire for people with special needs (IoT and cloud)

Summarizing the discussion and analysis as in Table 4 and Figure 3, a significant 90% of respondents have expressed their agreement regarding the necessity for an initial awareness phase for IoT and cloud computing implementation. However, additional efforts are still required to ensure the provision of IoT and cloud-related data, especially in the context of enhancing monitoring technology for individuals with special needs in both the public and private sectors. These technologies have facilitated connectivity for organizations of varying sizes, utilizing the Internet as a connecting medium. Consumers' demand for robust security measures in IoT and cloud technologies has been a priority, addressing concerns related to data privacy [45, 46].

6.1 Comparison of results with previous applications

We have made a comparison between the existing applications and the proposed app as shown in Table 5.

Table 5. Comparison table

Service	Divyang App	SN Children App	Inclu App	Accessibility Map App	The Proposed App
Software helping people with special needs	Slightly	Slightly	Slightly	Slightly	**Perfect**
Supporting distinguished people with special needs	Not perfect	Not perfect	Not perfect	Not impeccable	**Impeccable**
Offering services for people with special needs helps them to direct them in the streets of the city	Not perfect	Not perfect	Not impeccable	Impeccable	**Not impeccable**
Enabling people with special needs to add their needs for review by donors	Not perfect	Not perfect	Not impeccable	Not impeccable	**Impeccable**
Enabling the people with special needs to add their favorites to be reviewed by donors	Not perfect	Not perfect	Not impeccable	Not impeccable	**Impeccable**
Enabling the persons who like to donate to find the people who are suffering from disabilities.	Not perfect	Not perfect	Not impeccable	Not impeccable	**Impeccable**

7 CONCLUSION

This research explores the integration of IoT and cloud computing within the healthcare sector. We have examined related works in the realm of IoT-assisted healthcare, employing innovative technologies and acceptance strategies. Comprehensive statistical data has been presented and analyzed in tables, offering valuable insights. The study identifies that the healthcare sector in KSA is entering a phase where IoT and cloud healthcare solutions are gaining prominence, requiring focused efforts to encourage their adoption. The research process initially recognized the recent acceptance of IoT knowledge in the KSA healthcare domain, evidenced by respondents' feedback. Subsequently, six significant challenges were identified for both service providers and the community in embracing IoT and cloud healthcare solutions: organizational structure, management of comprehensive healthcare data, skill shortage in the IoT landscape, regulatory measures for IoT and cloud-enabled healthcare, patient and user data security, and enhanced reliability in IoT and cloud expansion. Furthermore, initial improvements involve enhancing broadband activities and the implementation of the IPv6 network. Additionally, local cloud storage is essential for managing vast health data and conducting information analytics. Moreover, leveraging data analytics is critical to transforming collected health information into actionable insights. Government bodies and stakeholders must expedite active measures, including regulatory frameworks and robust data protection mechanisms, to mitigate concerns over data integrity and privacy. Throughout this study, it becomes evident that the integration of IoT policies and cloud computing gradually enhances health systems over time. We have outlined discussions on confidentiality and security within IoT and cloud-based e-healthcare, providing an in-depth analysis of major issues, outcomes, and strategies. Furthermore, educational institutions should focus on enhancing the capabilities of IoT and cloud technologies for people with special needs. Concurrently, fostering reliable application development in IoT and cloud growth significantly aids healthcare research and advancement in these domains.

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9 REFERENCES

[1] L. Minh Dang *et al.*, "A survey on Internet of Things and cloud computing for healthcare," Seoul 143–747(05006), Korea MDPI, 2019.

[2] M. S. Hossain and G. Muhammad, "Cloud-assisted Industrial Internet of Things (IIoT) – Enabled framework for health monitoring," *Computer Networks*, vol. 101, pp. 192–202, 2016. https://doi.org/10.1016/j.comnet.2016.01.009

[3] L. Menvielle, A. F. Audrain-Pontevia, and W. Menvielle, *The Digitization of Healthcare: New Challenges and Opportunities*. London: Palgrave Macmillan, 2017. https://doi.org/10.1057/978-1-349-95173-4

[4] S. Wilk *et al.*, "An ontology-driven framework to support the dynamic formation of an interdisciplinary healthcare team," *Int. J. Med. Inf.,* vol. 136, pp. 1–12, 2020. https://doi.org/10.1016/j.ijmedinf.2020.104075

[5] G. Fersi, "Middleware for Internet of Things: A study," in *Proceedings of IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS)*, Fortaleza, Brazil, 2015, pp. 230–235. https://doi.org/10.1109/DCOSS.2015.43

[6] World Health Organization (WHO). World report on disability [Accessed June 2018].

[7] S. Kinne, D. L. Patrick, and D. L. Doyle, "Prevalence of secondary conditions among people with disabilities," *Am. J. Public Health*, vol. 94, pp. 443–445, 2004. https://doi.org/10.2105/AJPH.94.3.443

[8] L. I. Iezzoni, "Eliminating health and health care disparities among the growing population of people with disabilities," *Health Aff.*, vol. 30, pp. 1947–1954, 2011. https://doi.org/10.1377/hlthaff.2011.0613

[9] mHealth Report: Mobile Health Technology Trends and Innovations; mobileStorm. 2011. Available: http://mobilestorm.com/resources/digital-marketing-reports/reports/2011-mhealth-report/. [Accessed: January 16, 2022].

[10] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A survey," *Computer Networks*, vol. 54, no. 15, pp. 2787–2805, 2010. https://doi.org/10.1016/j.comnet.2010.05.010

[11] H. F. El-Sofany and S. A. El-Seoud, "The implementation of career and educational guidance system (CEGS) as a cloud service," *International Journal of Emerging Technologies in Learning*, vol. 15, no. 20, pp. 226–240, 2020. https://doi.org/10.3991/ijet.v15i20.16839

[12] H. F. El-Sofany and S. A. El-Seoud, "A novel model for securing mobile-based systems against DDoS attacks in cloud computing environment," *International Journal of Interactive Mobile Technologies*, vol. 13, no. 1, pp. 85–98, 2019. https://doi.org/10.3991/ijim.v13i01.9900

[13] S. Abou El-Seoud, I. Taj-Eddin, A. Nosseir, H. El-Sofany, and N. Abu Rumman, "A proposed pedagogical mobile application for learning Sign Language," *International Journal of Interactive Mobile Technologies* (*iJIM*), vol. 7, no. 1, pp. 46–55, 2013. https://doi.org/10.3991/ijim.v7i1.2387

[14] O. A. Ajigini, "Adoption of internet of things in the higher educational institutions: Perspectives from South Africa," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 16, pp. 165–181, 2023. https://doi.org/10.3991/ijet.v18i16.42317

[15] M. C. Domingo, "An overview of the Internet of Things for people with disabilities," *Journal of Network and Computer Applications*, vol. 35, no. 2, pp. 584–596, 2012. https://doi.org/10.1016/j.jnca.2011.10.015
[16] https://play.google.com/store/apps/details?id=com.wDivyang_4560398
[17] E. Jenkin, E. Wilson, K. Murfitt, M. Clarke, R. Campain, and L. Stockman, *Inclusive Practice for Research with Children with Disability: A Guide*. Melbourne: Deakin University, 2015.
[18] https://play.google.com/store/apps/details?id=com.andromo.dev601172.app1048277
[19] J. J. Hoover, "Special education eligibility decision-making in response to intervention models," *Theory into Practice,* vol. 49, no. 4, pp. 289–296, 2010. https://doi.org/10.1080/00405841.2010.510752
[20] https://play.google.com/store/apps/details?id=com.htcursos.appcmcg
[21] Z. Jacova, "The role of parents in the building of school inclusive culture, The Modern Society and Education," in *Proceeding of the VI Balkan Education and Science Congress*, Skopje, 2011, pp. 451–456.
[22] https://play.google.com/store/apps/details?id=ru.articul.kartadostupnosti
[23] D. Mayordomo-Martínez, *et al.*, "Sustainable accessibility: A mobile app for helping people with disabilities to search accessible shops," *International Journal of Environmental Research and Public Health,* vol. 16, no. 4, p. 620, 2019. https://doi.org/10.3390/ijerph16040620
[24] https://www.tutorialspoint.com/software_engineering/software_development_life_cycle.htm
[25] PR Newswire. Global Healthcare Internet of Things (IoT) Market Analysis and Forecasts 2016–2021 – Research and Markets. PR Newswire, July 2016.
[26] L. Wood, Wearable Devices and IoT in Healthcare Bundle Report 2016–2021 – Research and Markets. Business Wire. July, 2016.
[27] Y. Ma, Y. Zhang, O. M. Dung, R. Li, and D. Zhang, "Health internet of things: Recent applications and outlook," *Journal of Internet Technology*, vol. 16, no. 2, pp. 351–362, 2015.
[28] S. K. Mathur and H. V. Verma "Significance of DOI model for adoption of cloud computing," *International Journal of Emerging Trends & Technology in Computer Science*, vol. 3, no. 2, 2014.
[29] F. D. Davis, "A technology acceptance model for empirically testing new end-user information systems: Theory and results," Doctoral dissertation, 1986.
[30] M. Fishbein and I. Ajzen, *Belief, Attitude, Intention and Behavior: An Introduction Theory and Research*. Reading MA.: Addison-Wesley, 1975.
[31] E. Yadegaridehkordi, N. A. Iahad, and S. Asadi, "Cloud computing adoption behavior: An application of the technology acceptance model," *Journal of Soft Computing and Decision Support Systems*, vol. 2, no. 2, pp. 11–16, 2015.
[32] M. Yuvaraj, "Examining librarians' behavioral intention to use cloud computing applications in Indian central universities," Annals of Library and Information Studies, 2014. Available: http://www.scopus.com/inward/record.url?eid=2-s2.0-84893206604&partnerID=tZOtx3y1\nhttp://nopr.niscair.res.in/bitstream/123456789/26274/1/ALIS60(4)260-268.pdf
[33] PwC Health Research Institute, "Healthcare delivery of the future: How digital technology can bridge time and distance between clinicians and consumers," Price water house Coopers, 2014. Available: https://www.pwc.com/us/en/health-industries/top-health-industry-issues/assets/pwc-healthcare-delivery-of-the-future.pdf
[34] A. Ghorbel, S. Bouguerra, N. B. Amor, and M. Jallouli, "Cloud based mobile application for remote control of intelligent wheelchair," in *Proceedings of the 2018 14th International Wireless Communications & Mobile Computing Conference (IWCMC)*, Limassol, Cyprus, 25–29 June 2018, pp. 1249–1254. https://doi.org/10.1109/IWCMC.2018.8450366

[35] Y. K. Lee, J. M. Lim, K. S. Eu, Y. H. Goh, and Y. Tew, "Real time image processing-based obstacle avoidance and navigation system for autonomous wheelchair application," in *Proceedings of the Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC)*, Kuala Lumpur, Malaysia, 2017, pp. 380–385. https://doi.org/10.1109/APSIPA.2017.8282062

[36] C. Nave and O. Postolache, "Smart. Walker based IoT physical rehabilitation system," in *Proceedings of the 2018 International Symposium in Sensing and Instrumentation in IoT Era (ISSI)*, Shanghai, China, 2018, pp. 1–6. https://doi.org/10.1109/ISSI.2018.8538210

[37] G. Yang, J. Deng, G. Pang, H. Zhang, J. Li, B. Deng, Z. Pang, J. Xu, M. Jiang, P. Liljeberg, *et al*., "An IoT-Enabled Stroke Rehabilitation System Based on SmartWearable Armband and Machine Learning," *IEEE J. Transl. Eng. Health Med*., vol. 6, pp. 1–10, 2018. https://doi.org/10.1109/JTEHM.2018.2822681

[38] M. Fishbein and I. Ajzen, *Belief, Attitude, Intention, and Behavior: An Introduction Theory and Research*. Reading MA.: Addison-Wesley, 1975.

[39] E. Yadegaridehkordi, N. A. Iahad, and S. Asadi, "Cloud computing adoption behavior: An application of the technology acceptance model," *Journal of Soft Computing and Decision Support Systems*, vol. 2, no. 2, pp. 11–16, 2015.

[40] M. Yuvaraj, "Examining librarians' behavioral intention to use cloud computing applications in Indian central universities," Annals of Library and Information Studies, 2014. Available: http://www.scopus.com/inward/record.url?eid=2-s2.0-84893206604&partnerID=tZOtx3y1\nhttp://nopr.niscair.res.in/bitstream/123456789/26274/1/ALIS60(4)260-268.pdf

[41] Deloitte, "Connected health – How digital technology is transforming health and social care," Deloitte LLP, 2015.

[42] European Commission, "Green Paper on mobile health (mHealth)," European Commission, 2014. Available: http://ec.europa.eu/digital-agenda/en/news/green-paper-mobile-health-mhealth

[43] MIMOS Berhad, "National Internet of Things (IoT) Strategic Roadmap," MIMOS BERHAD. ISBN: 978-967-11398-3-7, 2014.

[44] S. Shrivastava, P. M. Jeyanthi, and S. Singh, "Failure prediction of Indian Banks using SMOTE, Lasso regression, bagging and boosting," *Cogent Economics & Finance*, vol. 8, no. 1, p. 1729569, 2020. https://doi.org/10.1080/23322039.2020.1729569

[45] C. Perera, M. Barhamgi, A. K. Bandara, M. Ajmal, B. Price, and B. Nuseibeh, "Designing privacy-aware Internet of Things applications," *Information Sciences,* vol. 512, pp. 238–257, 2020. https://doi.org/10.1016/j.ins.2019.09.061

[46] M. Syed, O. Humam, F. Ryan, and A. Mishary, "IoT framework based health care system for elderly and disabled people," in *International Conference on Recent Advances in Computer Systems (RACS 2015),* 2015. https://doi.org/10.2991/racs-15.2016.16

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