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THE DYNAMIC ROLE OF INTERNET OF THINGS (IOT) BASED APPLICATIONS IN HEALTHCARE DEVICES FOR ENHANCING EFFICACY OF TREATMENT

M.DHINAKARAN[1], P.DEEPTHI[2], RAKESH PERUMAL[3*], PRABHAKARA RAO KAPULA[4], ASHIM BORA[5]

1: Associate Professor, Department of Electronics and Communication Engineering, Government College of Engineering, Salem, Tamilnadu, India

2: Associate Professor, Department of Electronics and Communication Engineering, Government College of Engineering, Salem, Tamilnadu, India

3: Emergency care physician, Emergency care, GVK 108 emergency care project, Govt. of Tamilnadu, India

4: Professor, Department of ECE, B V Raju Institute of Technology, Narsapur, Telangana, India

5: Associate Professor and Head. Department of Mathematics. Diphu Government College, Diphu. Assam, India

*Corresponding Author: Rakesh Perumal; E Mail: dr.prpillai91@gmail.com

ABSTRACT

The health care industry has grown rapidly in the recent years due to the increased ability and potential in servicing more patients through technology. It is noted that a few years ago, the nature of diagnosis and treatment modalities is being carried only through physical analysis and treatment at hospitals, this has led to most of the individuals need to stay in the hospitals or wait for their turn to get a bed or appointment for through diagnosis and treatment.

The implementation of Internet of Things (IoT) possesses highest potential in connecting different medical sensors, practitioners, devices so as to offer better quality services to patients who are even located in a remote location. This has enabled in increasing the safety of the individuals, support in reducing operational expenses, increasing the accessibility of the services without even visiting the hospitals.

This study is involved in understanding the dynamic role of IoT based applications in the health care services which will result in increasing the efficacy of treatment. The overall advancement in IoT health care has been stated from the perspective of enhancing the health care quality, delivering better services and overcome the issues of providing health care to the individuals without visiting the hospital personally. To sum up, the present study enables in stating the comprehensive data and understanding related to different application of IoT in healthcare which intends in enhancing the treatment efficiencies.

Keywords: Internet of Things, Healthcare quality, Treatment efficacy, Healthcare devices, Chi square test

INTRODUCTION

The world has witnessed an exorbitant growth and development in the health care industry and has also contributed significantly to the world GDP, provide more employment and offer better care and services to the patients. A decade ago, the diagnosis and analysis of the patient disease was only made possible when the individual in at the hospital and after making complete physical analysis. Moreover, the time taken to prepare the diagnosis reports is high due to the technology and other related aspects. This has resulted in health care cost, not able to serve more patients and poor rural health care services and maintenance. However, with the advancement in technology the diagnosis of different diseases and monitoring the overall health can be made using different devices like smart watches, portable devices and smart phones [1]. This has helped the health care system to focus more on the patient-oriented approach, provide health care at more affordable cost, generate the reports at faster pace so that

appropriate treatment can be given efficiently.

Many crucial analyses from measuring the glucose level in the blood, blood pressure, heart rate monitoring, pO2 levels etc can be performed at patient convenient place with the support of the health care procession, this information is then transferred to the heath care centre database for quick diagnosis and analyses so that appropriate treatment can be suggested and support the patient to possess better health and wellbeing. The application of communication technology is growing rapidly with the advent of big data analytics, Internet of Things (IoT), Machine and Deep learning, Web 2.0 etc. The IoT has focused in enhancing the independence and diversity of the ability for the individuals to interact with the external environment in an efficient manner. The IoT tend to support in adhering to the stated protocol, diagnose the diseases based on the data collated from the various systems and enable in providing

quick communication to the stakeholders [2]. The increase in the adoption of IoT in the healthcare is due to the man advantage of providing more accurate information, enable in easier storage, lower cost and ability to forecast the future through the availability of data. The increase usage of technology and continuous upgradation in mobile and other technologies has made the communication and technology to expand even at rural areas. The IoT devices like the sensors, medical data transferring tools, vital signs data capturing, effectiveness of drug tracking etc. can be integrated with the physical devices so as to monitor and exchange the data and information using the communication tools. In the health care system, the sensors were mainly embedded or made as portable carrying devices which are used to collect and monitor the critical information of the patients like the blood glucose level, blood pressure, temperature, electrocardiograph and other vital signs. This information is then shared to the health care centre and medical professionals on a real time basis which enable them to track and monitor the health of the patients effectively [3].

This information is also used to analyse for making meaningful inference on the health condition, the data storage and cloud computing tend to play a crucial factor in the IoT system as more volume of information are sourced and recorded through different IoT devices. The sharing of the critical data with the health care professional through cloud networking enable in easier diagnosis and provide the necessary suggestion on the medical conditional based on the analysis. The IoT systems tend to provide a user interface which acts as dashboard for the professionals, apply appropriate control for delivering better health care services to the individuals at lower cost. The technologies which are applied in creating the health care system is more crucial, this is mainly due to the application of specific sensory and related equipments which enhances the usability of the IoT system.
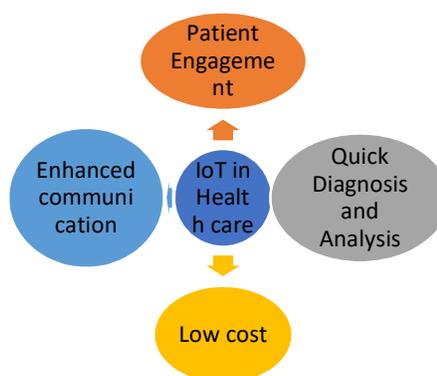

Figure 1: IoT based application in healthcare devices

(Source: Pradhan [1])

From **Figure 1** it can be stated that in order to enhance the efficacy of treatment using IoT, the major factors involved are quick diagnosis and analysis of the patent health, offering the services at lower cost, enhanced communication and better engagement and support from the patients so that appropriate treatment can be delivered to the patients and enable them in enhancing their health and wellbeing.

LITERATURE REVIEW

The IoT framework for healthcare applications helps to integrate the benefits of IoT technology and cloud computing into the medical field. It also defines the protocols with which patient data is transferred from various sensors and medical devices to a given healthcare network **[4]**.

The HIoT topology is the arrangement of the various components of the IoT healthcare system / network that are consistently related to the healthcare environment. A basic HIoT system mainly consists of three elements, such as publisher, broker and subscriber. The processor represents a network of connected sensors and other medical equipment that can operate separately or simultaneously to capture important patient information. This information can include blood pressure, heart rate, temperature, oxygen saturation, ECG, EEG, EMG, and so on. The publisher can continuously transfer this information over a network to a broker. The broker is responsible for processing and storing data received in the cloud. Finally, the subscriber participates in continuous monitoring of patient data, which can be stored on a smartphone, computer, tablet, etc. **[5]**. They can be viewed and viewed. Here, the author can process this data and provide feedback after noticing any physiological abnormalities or deterioration of the patient's health.

In the healthcare network, sensors and actuators are identified and managed separately, which helps the system to function correctly **[6]**. Due to the constant updating of IoT-based technology, the unique identifier may change during the life of the IoT system. Therefore, the device must have a device that updates this information to maintain the integrity of the device / health system. This may be because the configuration change not only affects the process of monitoring the network components, but it can also lead to incorrect diagnoses.

RESULTS

This section provides detailed understanding on the results related to the data collected by the researchers for the study.

Based on the analysis from **Table 1**, it is noted that 38.2% of the respondents were less than 30 years, 32.1% of the respondents were in the range between 30 –

40 years, 18.8% of the respondents were in the age group above 50 years, 10.9% of the respondents were in the age group of 40 – 50 years. 78.2% of the respondents were male and remaining were female, 55.8% of them were married and 44.2% of them were single or divorced. 72.1% of the respondents were working in full time and 27.9% of the respondents were working as part timers.

58.2% of the respondents were working as medical practitioner, 32.7% of the respondents were acting as nurses in the medical care centre and remaining 9.1% of the respondents were acting as support staff. 37% of the respondents were possessing less than 5 years of experience, 25.5% of the respondents were possessing an experience between 5 – 10 years, 12.7% of the respondents were possessing experience between 10 – 15 years, 19.4% of the respondents were having more than 20 years' experience and 5.5% of the respondents possess experience between 16 – 20 years of experience.

Correlation analysis

In order to understand and test the strength of the relationship between the two variables, the researchers intend to apply Karl Pearson's coefficient of correlation, a high positive correlation tend to enable in creating a strong relationship between the variables. A coefficient of correlation with range of +0.7 to +0.9 tends to state there

exist a strong correlation between the variables and the value in the range of +0.4 to +0.7 states that the values are moderately correlated etc. **[7]**.

The **Table 3**, states the correlation analysis between the independent variables: Quick diagnosis and analysis, low cost, enhanced communication and patient engagement and dependent variable enhancing efficacy of treatment. Based on the analysis it is noted that the coefficient of correlation between independent variables low cost and patient engagement possess higher positive correlation with value +0.923, the next highest is noted between the enhanced communication among the medical practitioner and quick diagnosis and analysis with +0.910. Overall, all the independent variables possess positive and higher correlation.

While comparing the coefficient of correlation between the independent variables and dependent variables, it is noted that patent engagement and enhancing efficacy of treatment through IoT is having a correlation value of +0.871, which is stated to be highly positive in nature, similar trend is noted among other variables. Hence, it can be concluded that there exist positive association between all the variables.

Hypothesis testing and confirmation

This part of the analysis tends to test the hypothesis and provide the interpretation

based on the output, in order to test the hypothesis, the researchers has applied chi square analysis using SPSS.

Hypothesis 1: There is no significant association between the influence of IoT towards quick diagnosis and analysis and enhancing efficacy of treatment to patients.

Based on the analysis from **Table 4**, it can be stated that the p value is 0.00 which is less than 0.05 at 5% level of significance, hence it can be concluded that there is a significant association between the influence of IoT towards quick diagnosis and analysis and enhancing efficacy of treatment to patients [8].

Hypothesis 2: There is no significant association between the IoT application in low-cost health care services and enhancing efficacy of treatment to patients.

Based on the analysis from **Table 5**, it can be stated that the p value is 0.00 which is less than 0.05 at 5% level of significance, hence it can be concluded that there is a significant association between the IoT application in low-cost health care services

and enhancing efficacy of treatment to patients

Hypothesis 3: There is no significant association between impact of IoT based application on enhanced communication and enhancing efficacy of treatment to patients

Based on the analysis from **Table 6**, it can be stated that the p value is 0.00 which is less than 0.05 at 5% level of significance, hence it can be concluded that there is a significant association between impact of IoT based application on enhanced communication and enhancing efficacy of treatment to patients [9-10].

Hypothesis 4: There is no significant association between IoT based patient engagement and enhancing efficacy of treatment to patients

Based on the analysis from **Table 7**, it can be stated that the p value is 0.00 which is less than 0.05 at 5% level of significance, hence it can be concluded that there is a significant association between IoT based patient engagement and enhancing efficacy of treatment to patients [11-12].

Table 1: Demographic analysis

Age of the respondents	Frequency	Percent
Less than 30 years	63	38.2
30 - 40 years	53	32.1
40 - 50 years	18	10.9
Above 50 years	31	18.8
Gender	Frequency	Percent
Male	129	78.2
Female	36	21.8
Marital Status	Frequency	Percent
Married	92	55.8
Single / Divorced	73	44.2
Employment Status	Frequency	Percent
Full time	119	72.1

Part time	46	27.9
Role	**Frequency**	**Percent**
Professional Medical Practitioner	96	58.2
Nurses	54	32.7
Other support staff	15	9.1
Total	165	100
Total years of work experience	**Frequency**	**Percent**
Less than 5 years of experience	61	37
5 - 10 years	42	25.5
10 - 15 years	21	12.7
16 - 20 years	9	5.5
Above 20 years	32	19.4

Table 2: Correlation Range

Coefficient of correlation	Correlation
0.0 - ±0.2	Little correlation
±0.2 - ±0.4	Weak correlation
±0.4 - ±0.7	Correlated
±0.7 - ±0.9	Strong correlation
±0.9 - ±1.0	Very strong correlation

Table 3: Karl Pearson's coefficient of correlation

Correlations	Quick Diagnosis and Analysis	Low Cost	Enhanced Communication	Patient Engagement	Enhancing Efficacy of Treatment
Quick Diagnosis and Analysis	1	.853**	.910**	.799**	.773**
Low Cost	.853**	1	.867**	.923**	.855**
Enhanced Communication	.910**	.867**	1	.843**	.838**
Patient Engagement	.799**	.923**	.843**	1	.871**
Enhancing Efficacy of Treatment	.773**	.855**	.838**	.871**	1
N	165	165	165	165	165
** Correlation is significant at the 0.01 level (2-tailed).					

Table 4: Chi square analysis between quick diagnosis and analysis & Enhancing efficacy of treatment

Quick Diagnosis and Analysis * Enhancing Efficacy of Treatment Crosstabulation

Count

		Enhancing Efficacy of Treatment				Total
		Disagree	Neutral	Agree	Strongly Agree	
Quick Diagnosis and Analysis	Strongly Disagree	4	0	0	0	4
	Disagree	16	0	0	0	16
	Neutral	0	12	5	0	17
	Agree	0	5	10	26	41
	Strongly Agree	0	5	27	55	87
Total		20	22	42	81	165

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	222.950[a]	12	.000
Likelihood Ratio	167.527	12	.000
Linear-by-Linear Association	98.054	1	.000
N of Valid Cases	165		

a. 11 cells (55.0%) have expected count less than 5. The minimum expected count is .48.

Table 5: Chi square analysis between low cost & Enhancing efficacy of treatment

Low Cost * Enhancing Efficacy of Treatment Crosstabulation

Count

		Enhancing Efficacy of Treatment				Total
		Disagree	Neutral	Agree	Strongly Agree	
Low Cost	Strongly Disagree	13	0	0	0	13
	Disagree	7	0	0	0	7
	Neutral	0	14	5	0	19
	Agree	0	3	28	16	47
	Strongly Agree	0	5	9	65	79
Total		20	22	42	81	165

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	275.945[a]	12	.000
Likelihood Ratio	209.307	12	.000
Linear-by-Linear Association	120.002	1	.000
N of Valid Cases	165		

a. 10 cells (50.0%) have expected count less than 5. The minimum expected count is .85.

Table 6: Chi square analysis between Enhanced communication & Enhancing efficacy of treatment

Enhanced Communication * Enhancing Efficacy of Treatment Crosstabulation

Count

		Enhancing Efficacy of Treatment				Total
		Disagree	Neutral	Agree	Strongly Agree	
Enhanced Communication	Disagree	20	0	0	0	20
	Neutral	0	12	0	0	12
	Agree	0	5	10	10	25
	Strongly Agree	0	5	32	71	108
Total		20	22	42	81	165

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	255.428[a]	9	.000
Likelihood Ratio	182.378	9	.000
Linear-by-Linear Association	115.099	1	.000
N of Valid Cases	165		

a. 7 cells (43.8%) have expected count less than 5. The minimum expected count is 1.45.

Table 7: Chi square analysis between patient engagement & Enhancing efficacy of treatment

Patient Engagement * Enhancing Efficacy of Treatment Crosstabulation

Count

		Enhancing Efficacy of Treatment				Total
		Disagree	Neutral	Agree	Strongly Agree	
Patient Engagement	Strongly Disagree	5	0	0	0	5
	Disagree	15	0	0	0	15
	Neutral	0	17	5	0	22
	Agree	0	5	28	27	60
	Strongly Agree	0	0	9	54	63
Total		20	22	42	81	165

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	281.532[a]	12	.000
Likelihood Ratio	217.357	12	.000
Linear-by-Linear Association	124.514	1	.000
N of Valid Cases	165		

a. 9 cells (45.0%) have expected count less than 5. The minimum expected count is .61.

DISCUSSION

The application of IoT concepts in health care services enables in deployment of the IoT technologies in different systems covering ECG monitoring, Asthma analysis, Medication management, Drug allergies, Rehab management etc. The increased development in the IoT technology has enabled in making the health care services more affordable and user-friendly portable devices covering smart phones, wearable gadgets, other medical devices. These IoT systems can be applied in combining with the health care devices through portable devices, sensors, smart phones, smart wearables etc. so as to collate the information related to patient health, make quick diagnosis and analysis of the disease, understand the pattern, monitor the health of the patients in real time, enhance communication, engage the patents well so as to provide better medical services at lower cost [13]. Patient monitoring and quick diagnosis are considered as the critical aspect for making the implementation of IoT devices to the patients, furthermore, it enables in offering medical services through low cost and better engagement. When a IoT system collects the information, the patient data are then transferred t the medical centre hub where the professionals and nurses can view, monitor and analyse them for effective analysis. They also use these aspects for understanding the drug effectiveness, recommend better treatment and generate alerts so as to enhance the efficacy of the services [14].

Based on the analysis it is noted that the coefficient of correlation among the independent variables and dependent variable are high, showing that there exists better linear relationship. Furthermore, the chi square analysis has stated that there exist a significant association between the variables and hence it can be stated that the

application of IoT based health care devices support in enhancing the efficacy of treatment for the patients.

CONCLUSION

Ten years ago, it was only possible to diagnose and analyze a patient's disease when the person was in the hospital and after a thorough physical examination. In addition, the time required to prepare diagnostic reports is high due to technology and other related considerations. This resulted in healthcare costs, inability to serve more patients and poor health and maintenance services in rural areas. But with the development of technology, the diagnosis of various diseases and general health control can be performed through various devices, such as smart watches, mobile devices and smartphones. In the healthcare system, the sensors were either integrated or designed primarily as portable vehicles used to collect and monitor critical patient information such as blood sugar, blood pressure, temperature, ECG machine and other important points. This information is shared in real time with the health center and care staff, so that they can effectively monitor and track patients' health. Based on the analysis, it is noted that the correlation coefficient between the independent variables and the dependent variable is high, which indicates that the linear relationship is better. Furthermore, the x-square analysis showed that there is a

significant correlation between the variables and therefore it can be discussed that the use of IoT-based health devices promotes efficiency and treatment for patients.

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