Multi-Disciplinary Journal
ISSN No- 2581-9879 (Online), 0076-2571 (Print)
www.mahratta.org, editor@mahratta.org

Innovation in Healthcare Services using Internet of Medical Things(IOMT) and Digital Platforms

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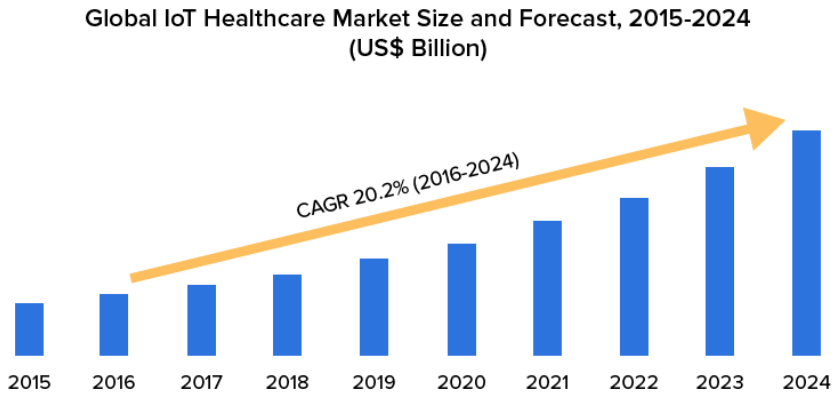
Abstract
Health has become a very vital element in todays stressful competitive world and slowly Human beings are realizing the importance of Healthcare. Further the Covid-19 pandemic has complicated the problems and the pandemic has led to loss of human life all over the world. Use of Technology in healthcare will certainly enhance the efficiency of the overall Healthcare system. The use of Technology , Digital Platform sand related Applications in healthcare will give impetus to Medical treatment processes. It will over-haul the current Medical systems and processes by way of implementing Modern Technology, improved connectivity and Artificial intelligence. It can benefit patients of all category, provide access to remotely located patients with a fast diagnosis of diseases as well as finding an apt cure for it. This paper makes an attempt to find the real issues/advantages of IOMT innovation through Primary and secondary data gathering and analysis and make suggestions/recommendations based on Responses to Primary data and relevant secondary data. The research will try to find if Innovation using IOT and technology will improve the process of Healthcare Quality in our country.

Keywords: IOMT, Digital Platforms., Health-care advances, IOMT Efficiency/advantages, 5G

Overview
The concept of internet of medical things (iomt) is a basically integration of medical devices and digital platforms supported by AI. They collect patients data in on-line mode and the digital platforms carry out analysis of this data under supervision of doctors/medical staff for fast diagnosis and action plan/treatment to patients. There are some concerns in implementation, challenges and limitations which are bringing in hurdles in accepting the technology. But the advantages outpace the challenges and are under resolution by the iomt industry.

A. Where Does IoT Fit in Healthcare?



The graph shows that IOT in Healthcare market is growing and is likely to penetrate the market showing good potential globally due to its salient features and advantages.

The Research Problem

The problem faced in Healthcare services are:-

- Access of Medical services to people staying in Rural areas/ Villages.
- Non availability of adequate number of Doctors/specialists. Long waiting time for appointments in Hospitals.
- High cost of Treatment
- Quality and efficiency of Medical services not very satisfactory.

B. Impact of Timely Treatment in Healthcare

A lot of times it happens that patients don't get medical attention on time which can harm their health severely. Some of the reasons are; of untimely treatment are no beds in Hospitals, Not able to reach Hospital in time in Emergency cases due to Traffic jams, unavailability of specialist Doctors, Late identification of type of diseases, etc.. This may cause potential loss to impacted families.

C. Awareness about a Disease/Complications

Most of the time, people have no idea that they are suffering from an illness. To identify any signs, a visit to the doctor is required. If heart rate checkups, blood pressure level, sugar level, etc. are regularly monitored then patients can be alarmed about any upcoming threats to their health.

D. Access To Healthcare Facilities

The problem of Access to Healthcare services specially for people staying in remote and rural areas is a major issue and that prevents them from getting health-care services. This is a major issue for having access to specialist doctors and so Digital platforms/IOT and connectivity will help to improve the situation. (vital for Rural areas)

E. The Internet of Medical Things (IOMT)

Not only will IoMT be able to prevent any upcoming diseases but also will be able to cure the ones that have already been caused. The technology has been so advanced, that now remote monitoring of patients is possible.

The Internet of Medical Things has various branches of specialisation with solutions, as per the MehealthcareIndutry specialisations/requirements. The on-body segment focuses on smart wearables of various category as per disease/organ specialisation. The products available in market are from e-Fitbit, Samsung medical, etc.

F. The Various Segments of IOMT

- **The in-home segment**:- It is meant for Personal use for monitoring own health . It consists of PERS (personal emergency response systems) nand RPM (remote patient monitoring) type smart devices.
- **The community segment**:-
  (a) Kiosks that dispense products and provide services.
  (b) Transportation services to patients like vehicles.
  (c) Data for Emergency response.
  (d) IOMT smart devices that act like medical camps.
  (e) Inventory and logistics eco-system that keep a record of all the medical inventory and patient data – May be based on cloud computing technology.
- **The in-clinic category**:- This category includes IoMT devices used inside a clinic premises . These are all smart and connected devices with medical sensors, connectivity and database servers with AI for diagnosis of disease is deployed.

- **Management/Supervory Systems**:-. All connected platforms (probably on cloud computing technologies)
  (a) Asset management.
  (b) Personnel management,
  (c) Patient flow management)
  (d) Environment and energy monitoring.

To summarise Technology and fast connectivity with AI/ML is bringing in a lot of efficient medical devices with automation for fast treatment to patients even in remote areas.

G. The Advantages of IoT in Healthcare?
Major advantages are as follows:-

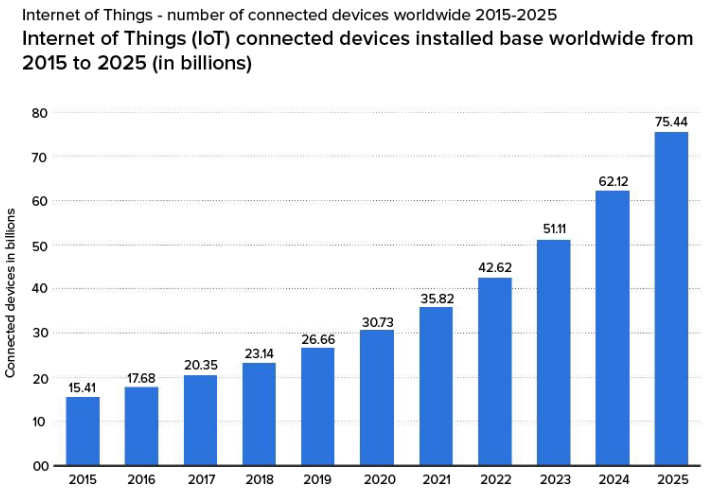
- On-line data reporting and processing
- Connected eco-system at reasonable cost
- Fast Data analysis and Diagnosis of disease with AI technology.
- Real-time and faster processing gives efficiency.
- Being always connected gives results in Mobility mode also- by use of smart phones. (Universal access)

H. Use Cases of IOMT in Healthcare

- Remote patient monitoring
- Reducing wait time
- Keep track of hardware maintenance
- Tracking employees and patients
- Drug management
- Identification of chronic diseases
- Smart Wearables/Use of AR/VR

I. Challenges faced in Implementation of IOMT

- Privacy and security
- Multiple devices and protocol integration
- Overloading and inaccuracy
- Fast Connectivity (Like 5G)
- More users/Devices – shortage of IP addresses



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J. Hypothesis

There are 2 Hypothesis

1. .**Null Hypothesis H0 1(1)** :- A significant majority of the Population felel that IOT in Medical care will improve the overall efficiency and Quality of Healtcare services at reduced cost.
2. **Null Hypothesis H0 (2)** :- A significant majority of Population feel that IOT in Medical care and Digital platforms will enhance Access of Healthcare facilities to patients in Rural/Remote areas of our country.

Sample Size Calculation: Cochran's formula is considered especially appropriate in situations with large populations. Here we have used the Cochrans formula as the graduate student population in Pune Metropolitan region is around 3 Lakh.
The Cochran formula is:

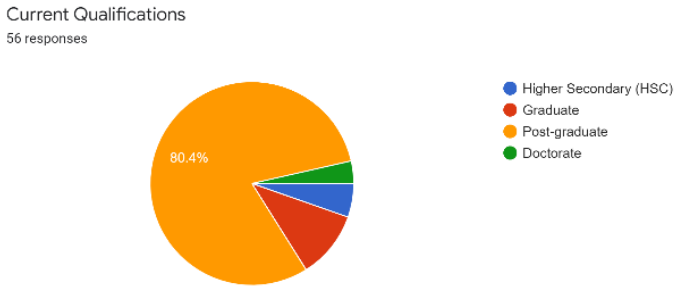
$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:
n = sample size
Z= obtained from Z table. (for 95% reliability level and Z is 1.966 as per standard normal table)
e is the desiredl of precision (i.e. the margin of error)
p is the (estimated) share of the population which has the ascribe in discussion.
q is 1 – p.
Taking 95% as confidence level we have Z value = 1.966 from Z table.
Therefore Error (e) = 5% = 0.05
p = Total no. of Graduates in Pune Metropolitan Region (MMR) / Total population of Pune MMR .
= 3 Lakh /74 Lakh = 0.04
q = 1 – p
= 1 – 0.04
= 0.95
For 95% Confidence level :-
By using above Cochransformula we calculate sample size for Pune city Region
Therefore, **ideal Sample Size (n)** = 1.96 * 1.96 * 0.104*0.95 / 0.05 * 0.05
= 0.37/0.0025= **51**

Survey Methodology & Data Collection:-
A survey was conducted for getting primary data preferably from the graduate student community from Pune city. A Questionnaire was designed for Data collection and Responses were obtained. A total of 12 Questions (Nominal scale and Likert scale) were made for the survey and Responses were obtained on-line through Google Form Link. A total of 55 graduates responded to the survey.

Data Analysis & Hypothesis Testing:-
When we consider, the null speculation is true, the sampling distribution of the test statistic is called as chi-squared distribution. The chi-squared test helps to determine whether there is a notable difference between the normal frequencies and the observed frequencies in one or more classes or categories. It gives the probability of independent variables.

Data Collection:-
Out of the 55 respondent's majority were all post graduates and having good knowledge about IOMT. All have visited Hospitals for some reason.



Testing of Hypothesis H0 (1):- The response to this Hypothesis Question was analysed with Chi-square test in Excel Advanced and the Calculations/data is as follows:

Observed and Expected Values:

The statistical calculations were done using Advance Excel . There were 55 respondents to the Questionnaire and most of them were Graduate students from Pune city who had awareness about IOT/IOMT. The analysis and Cgi-square testing data is as follows:-

Observed Table					**Expected Table**			
Do you feel that the overall management of Medical Services delivered via digital platforms or the concept of IOT has resulted in an improvement of overall quality and efficiency of Medical Facilities?		Gender		**Observed Values**		Gender		**Expected Values**
	Response	Female	Male	Grand Total	Response	Female	Male	Grand Total
	Neutral	3	12	15	Neutral	5.18	8.45	13.64
	satisfied	9	27	36	satisfied	12.44	20.29	32.73
	unsatisfied	0	4	4	unsatisfied	1.38	2.25	3.64
	d Total	19	31	55	d Total	19	31	50
	N (Respondents)	55			**N**	55		

Chi-Square Test Results:-

P- Values	**Testing with Alfa P=0.05**	**Formula from Excel**			
1. . Null Hypothesis H0 1(1) :- Most o fthe Respondents felel that IOT in Medical care will improve the overall efficiency and Quality of Healtcare services at reduced cost.		Gender		CHISQTEST Formula from Excel	Results of Hypothesis Testing - . Null Hypothesis H0 1(1) :- A significant majority of the Population felel that IOT in Medical care will improve the overall efficiency and Quality of Healtcare services at reduced cost.
	Response	Female	Male	Grand Total	CHI-Sq Alfa= 0.88
	Neutral	0.02	0.06	0.08	Chi-Sq P value=o.o5
	satisfied	0.05	0.11	0.16	
	unsatisfied	0.25	0.39	0.64	The Chi-Sq ALFA value 0.88) IS GREATER THAN Ch-Sq P Value (0.05) so Null Hypothesis is accepted
	d Total			0.88	
	Chi-Square Alfa Value		**0.88**		
	P- Value		**0.05**		

As per above test results the H0(1) Null Hypothesis is accepted.

Testing of Hypothesis H0 (2):

The analysis and Cgi-square testing data is as follows:-

Observed Values - Hypothesis H0(2)					Expected Values			
Do you feel that the overall management of Medical Services delivered via digital platforms or the concept of IOT has resulted in better access to medical care/facilities to patients staying in remote rural areas?		Gender		Observed Values		Gender		Expected Values
	Response	Female	Male	Grand Total	Response	Female	Male	Grand Total
	Neutral	2	5	7	Neutral	1.53	5.47	7.00
	satisfied	8	21	29	satisfied	6.33	22.67	29.00
	unsatisfied	2	17	19	unsatisfied	4.15	14.85	19.00
	d Total	12	43	55	d Total	12	43	55
	N (Respondents)	55			**N (Respondents)**	55		

Chi-square Test Results:-

P- Values Testing with Alfa P=0.05 Formula from Advance Excel					Chi-Square Test
. Null Hypothesis H0 (2) :- A significant majority of Population feel that IOT in Medical care and Digital platforms will enhance Access of Healthcare facilities to patients in Rural/Remote areas of our country.		Gender		CHISQTEST Formula from Excel	Results of Hypothesis Testing - . Null Hypothesis H0 (2) :- A significant majority of Population feel that IOT in Medical care and Digital platforms will enhance Access of Healthcare facilities to patients in Rural/Remote areas of our country.
	Response	Female	Male	Grand Total	CHI-Sq Alfa= 3.65
	Neutral	0.34	0.79	1.13	Chi-Sq P value= 0.05
	satisfied	0.37	0.81	1.18	The Chi-Sq ALFA value 3.65) IS GREATER THAN Ch-Sq P Value (0.05) so Null Hypothesis is accepted
	unsatisfied	0.49	0.86	1.35	
	d Total	1.20	2.45	3.65	
	Chi-Square Alfa Value		3.65		
		P- Value	0.05		

As per above test results the s H0(2) Null Hypothesis is accepted.

Other Major Findings from the Survey:-

- Cost of Treatment- 44% respondents felt that IOMT will reduce the cost of treatment to patients, 32% were Neutral and 23% felt that it will not have any impact.
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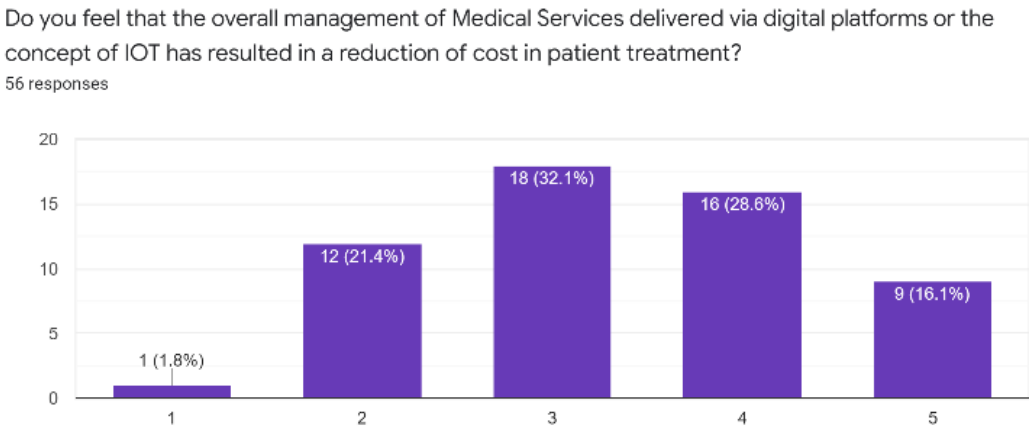
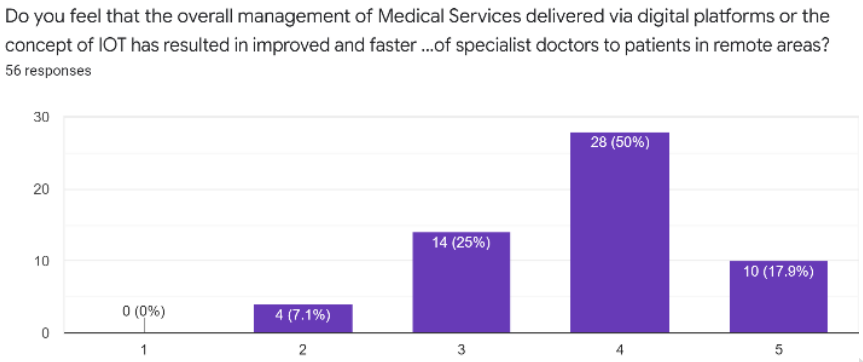


- Access to Medical Services for Rural area Population :- 67% feel that IOMT will enhance access to Medical care to Rural areas., 25% were neutral and 8% felt Negative about it.



- Impact of New Innovative technologies:- More than 81% respondents felt that Innovation and technology will enhance Healthcare services to all stake holders .
- Majority (80%) of respondents agree that there is short gage of Doctors and that they are stressed due to heavy load of patients..
- Only 40% of respondents' feel satisfied with the quality of Medical services in India.

Conclusion & Recommendations:-

- The modernization of Medical care facilities and Digital platforms along with a high speed data connectivity like 5G Technology Network will certainly enhance the over-all efficiency of Health-care management. It will also enable delivery of fast medical facilities to remote areas and Rural areas where currently, we lack all these facilities. The implementation of IOMT will increase with more acceptance by all the stake holders in society once we overcome the current barriers and challenges in IOMT. The IOMT supported by Artificial Intelligence (AI) and Neural Networks , Cloud Computing , Robotics in surgery, Data mining will enable fast diagnosis of complex disease with reduced cost to patients and better Health care services can be provided by Hospitals. IOMT is seen to improve the Quality of Medical services, Timely and Fast /accurate diagnosis and timely treatment at reduced cost to society. It will create a win-win situation for all stake-holders in Medical services providers and patients. More than 80% feel that IOMT/Technology is an answer to enhance the Medical facilities , decrease load on Doctors/Hospitals, Reduce cost of treatment and improve Service Quality to patients .

Future Scope for Research:-

This paper covers only the predictions and probable scope/potential of IOMT. The results show and secondary data show that IOMT has great potential in our country and will give impetus to the process of Medical services for benefit of the society. The future scope of study is to explore the practical applications of IOMT, Eco-system, Cost analysis, Reach to Rural area and Hospital/Doctors treatment management applications. Implementation.

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