International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

A Study on Consumer Behavior towards Connected Medical Devices and Adoption of IOMT Post the COVID-19 Pandemic

Sarvesha Marathe[1], Dr. Rohan Kesarkar[2]

[1]B.E Computer, Student of PGDM Healthcare at Prin. L. N. Welingkar Institute of Management Development and Research, Mumbai, India
Email: *msarvesha2[at]gmail.com*

[2]PhD, Assistant Professor (Healthcare Management & Business Design), Prin. L. N. Welingkar Institute of Management Development and Research, Mumbai, India
Email: *rohannk27[at]gmail.com*

Abstract: ***Since the COVID-19 pandemic, people have become more health-conscious and have started adopting digital healthcare solutions and medical devices. Various market reports, including Newswire report, have identified consumer awareness of Internet of Things (IoT)-based medical devices as a primary growth driver of the Internet of Medical Things (IoMT) market. This study aims to explore the awareness and purchase intentions of connected medical devices among Indian consumers in Tier-1 and Tier-2 cities. Online cross-sectional survey responses from 100 general consumers and 10 doctors were analyzed using tools like IBM SPSS for descriptive statistics and hypothesis testing. The consumer survey indicates that more than 70% of respondents are aware of IoT home-use medical devices and wearable devices, but lack in-depth awareness. The top factors influencing buying decisions are the doctor's recommendation, ease of use of the device, and quality of results. The doctor survey indicates that 6 out of 10 doctors are unsure whether they will recommend such medical devices to patients. The primary barrier perceived by doctors is concern over data privacy issues. Hypothesis testing indicates that as consumer awareness increases, the intention to purchase IoT-based medical devices also rises. The recommended actions will help raise awareness, ultimately expanding the growth potential of the IoMT market.***

Keywords: Internet of Things (IoT), Internet of Medical Things (IoMT), connected medical devices, Correlation

1. Introduction

Due to the COVID-19 pandemic, patients have become more aware, they participate actively in healthcare decisions, focus more on self-care, and demand transparency. As per a recent KPMG report, this shift in consumer behavior is turning patients into smart consumers. Consequently, healthcare providers are compelled to change their engagement strategy with patients. With the rapid expansion of health data and the advancement of technology, notable progress has been made in connected medical devices, including sensors, implants, and wearables. Accelerated digitization during the pandemic has led to an astronomical growth in demand for the Internet of Medical Things (IoMT). As per a recent Deloitte report, most MedTech companies in the IoMT market are adopting strategies to increase their market presence and share risk. The recent Globe newswire report estimated that the global IoMT Market size will reach USD 187.60 billion by 2028, with a CAGR of 29.5% during the forecast period. The reports conclude that the two major factors driving the growth of the IoMT market in India are the increasing awareness of health issues among the people and the growing adoption of digital technologies in healthcare.

What is IoMT? The network of internet-connected medical devices and applications that connect to healthcare IT systems forms the Internet of Medical Things (IoMT). The connected medical devices can collect, analyze, and transmit health data to the cloud/ servers by connecting to healthcare provider networks. The types of IoMT-connected medical devices, according to product, are stationary, implantable, and wearable medical devices. The IoMT market is segmented by application, including Telemedicine, Clinical operations, connected imaging, Inpatient monitoring, remote patient monitoring, Medical management, and others.

COVID-19 has positively affected the market growth. The drivers of the market growth are a drastic increase in the number of patients, a rise in the number of connected medical devices, and the technologies that are capable of capturing and transmitting medical data, and increasing pressure on doctors to provide advanced healthcare services. The pandemic has driven the healthcare consumers' demand for wellness or value-based health rather than treatment. This accelerated the need for remote patient monitoring and the usage of IoMT in ambulatory and home care.

2. Literature Survey

1) Dr. S. Vaidheeswaran, Mr.K.Karmugilan,2021[1] in their research study on consumer buying behavior on healthcare products and medical devices during Covid19, concluded that there is a significant relationship between 'becoming more health conscious due to COVID-19' and 'buying more health care products due to Covid19.
2) Mary Linda, Ruchi Kanhere et al (ResearchGate), 2021[2] in their research study focused on understanding the awareness, usage, and buying behavior of consumers of home-use medical devices. The study concludes that 62% of participants are aware of the devices and found that among those who do not use the devices, the majority of them do not know how to use the devices.

3) *Ganji Kashmira, Sashikala Parimi, (ResearchGate), 2021*[3] in their research study focused on the study carried out to analyze user's perception of the IoT-based healthcare devices and the impact of Covid19. The ANN (artificial neural network) model for analysis found that the majority of the respondents in the survey were likely to recommend IoT-based smart healthcare devices. The trust of the consumers in sharing the data and the reliability of the device plays an important role in buying decisions, along with the increased health consciousness due to the pandemic. There is a need to develop education campaigns to educate the public on how to use IoT-based healthcare tools.
4) *Garima Sahni et al, 2022*[4], research study throws light on how aware Indians are about the home use of medical devices during Covid19. The middle-class consumers (75%) think the quality is the critical component despite the price-conscious market because the patient's safety is of utmost importance. The majority of expenditure in India is still out of- pocket by patients, so the medical devices provide significant cost savings to economically disadvantaged consumers. To establish trust in IoMT devices, it is important to build a data privacy chain and trust domains of various players.
5) *Shweta Nanda et al, 2019*[5] in her thesis, studied the awareness and purchase behavior of wearable device users, and the penetration modes of IoT-based wearable medical devices in India. People who have awareness in the Medical Tech field or Sports or fitness tech are receptive to customized medical wearable offerings. Further, the age group 35-55 years more believes that facilities on smartphones, which are compatible with the wearable medical devices are important when making a purchase decision.
6) *Pratibha Raju, ETHealthWorld, 2021*, in an article about connected cardiac care in India, highlights that monitoring and treatment with real-time response to acute situations for early detection is the biggest disruption in cardiac home care.
7) According to Mint's article, 2020, the shift in consumer behavior will change the game for the healthcare industry. It is essential to leverage changing patterns of consumption and health-seeking behavior due to the Covid19 pandemic. It is beneficial to unlock demand from new regions and consumers to reach remote areas.

3. Problem Definition

The objectives of this research are:
1) To understand knowledge, awareness and general perception of population towards connected medical devices and IOT.
2) To understand the demographic and geographic profiles of the consumers.
3) To understand the factors influencing consumers' buying decision towards connected medical devices post Covid-19 pandemic.
4) To highlight the adoption of Internet of Medical Things (IoMT) in India.

4. Research Methodology

4.1 Research design

The duration of the research study is March- April 2022. This research is structured, based on large samples and involves prior formulation of specific hypothesis. The secondary research describes the gist of the findings stated in previous research papers available on the internet to develop the background. The survey consist of 12 questions including demographics, IoMT awareness related questions, perception and buying intention of connected medical devices. The study population for both the general consumer and doctor surveys belong to the age group 16 to above 65 years and limited to tier 1 and tier 2 cities in India.

4.2 Sampling method and sampling size

The chose sampling method is simple random sampling. With the help of the general consumer and doctor surveys, the study includes a subset of participants randomly selected from a population. Thus, each member of the population has an equal chance. The sample size for general consumer survey is 100 and doctor survey is 10.

4.3 Inclusion and exclusion criteria

The study excludes the population from tier 3 cities and villages for both the surveys. For the doctor survey, doctors from the departments related to general medicine and surgery, community medicine, outpatient and physiotherapy department are only included because of the topic of the study. The study excludes the responses from doctors related to any other departments other than mentioned above.

4.4 Data collection and analysis

Based on the objectives framed, the study consists of a well-structured google questionnaire surveys to collect primary data from the general consumers and doctors. The survey responses were collected from random patients in hospitals, colleague, relatives, friends, and from general people in public places such as malls, residents. The survey responses from doctors were obtained through structured personal interviews to ensure accuracy and completeness of the data. The data analysis involves descriptive statistics analysis techniques such as Percentage and frequency distribution, cross tabulation, chi- square for interpretation of results and inferential statistics. Based on the secondary research understanding, the study has framed a hypothesis before collecting the primary data. The study has used Spearman correlation for hypothesis testing. The tools used for data analysis are IBM SPSS and MS Excel.

4.5 Underlying hypothesis

(Null hypothesis): There is no significant relationship between 'Becoming more aware of the IoT- based connected medical devices due to COVID19 pandemic' and 'Intention to buy or use IoT- based connected medical devices due to COVID-19'. HI (Alternate hypothesis): There is a significant relationship between 'Becoming more aware of the IoT-based connected medical devices due to COVID19 pandemic'

and 'Intention to buy or use IoT- based connected medical devices due to COVID-19'.

Limitations: The size of the sample is limited as per the number of responses due to limited time- period of the study. The sample is large and representative of the population. The quantitative data analysis in the research done based on data provided by the respondents. Respondent bias may be there as it is often prevalent in structured surveys.

5. Data Analysis and Results

5.1 General Consumers survey analysis

Percentage frequency distribution and Cross-tabulation Analysis:

Table 1: Frequency distribution of demographic variables and geographic variables

Variable	Group	N (Frequency)	%
Age	16- 25	43	43.0%
	26- 35	25	25.0%
	36- 45	6	6.0%
	46- 55	15	15.0%
	56- 65	8	8.0%
	Above 65	3	3.0%
	Total	100	
Gender	Female	65	65.0%
	Male	35	35.0%
	Total	100	
Location	Tier 1 (Metropolitan cities)	38	38.0%
	Tier 2 (Cities)	62	62.0%
	Total	100	

Interpretation: The above table indicated that the maximum number of participants consisted in the age group of 16-25, 25- 35, and 46-55, the majority of them are females. It is apparent that the majority of the participants reside in Tier 2 cities.

General awareness and usage of internet connected smart appliances

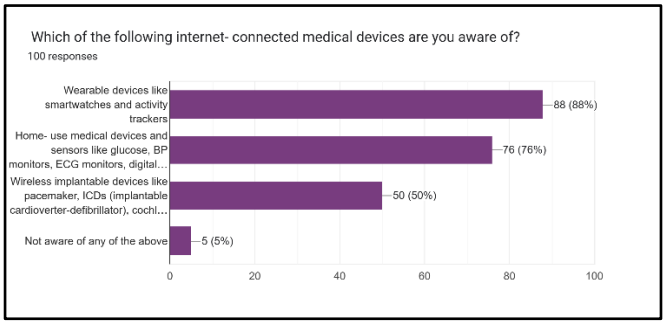
From the survey, it was evident that 95% of respondents had internet-connected devices at home such as smartphones, laptops, etc. More than 90% of the respondents have heard of smart home appliances or devices. As smart home appliances are IoT-based products, it can be said that the majority of the respondents are aware of/ or have heard of IoT-based products.

Perceived need and importance of IoT- based connected medical devices

The majority of the respondents from both tier cities feel that it is important to have connected medical devices due to the Covid19 pandemic or a chronic patient in the family. Only 6 respondents do not think that such medical devices are needed.

However, less than 50% of respondents are interested to get emergency or regular health monitoring services at home. This is despite the fact that IoT-based connected medical devices have major applications in remote health monitoring, which help the patients check their vitals at home during an emergency and get a consultation.

Awareness of the types of IoT- based medical devices



Graph 1: Awareness of types of IoT medical devices

More than 75% consumers are aware of the wearable devices such as smartwatches, activity trackers and home use medical devices and sensors such as glucose monitors, ECG monitors.

Table 2: Frequency statistics about types of IoT medical devices awareness

No. of types selected	N (Frequency)
1 (Aware of only 1 type)	21
2 (Aware of 2 types)	39
3 (Aware of 3 types)	40
Total	100

Forty percent of the respondents are aware of three or more types of IoT medical devices.

Sources of awareness and satisfaction level

In the survey, it was evident that 80% of people have gained awareness of such medical devices through the internet or social media, whereas more than 60% have heard of such devices from family and friends or the public media such as TV, and newspaper, etc. Interestingly less than 40% of respondents say that they received recommendations to utilize such medical devices from doctors.

The survey asked the consumers who have utilized any of the connected medical devices (wearables/ home-use devices and sensors, and wireless implantable devices) to rate their satisfaction level. Only 68 respondents claim that they have used such devices, and among them, 27 respondents rated neutral and 36 respondents rated satisfied. Thus, it is evident that IoT-based connected medical devices are beneficial for the user and provide a satisfactory user experience.

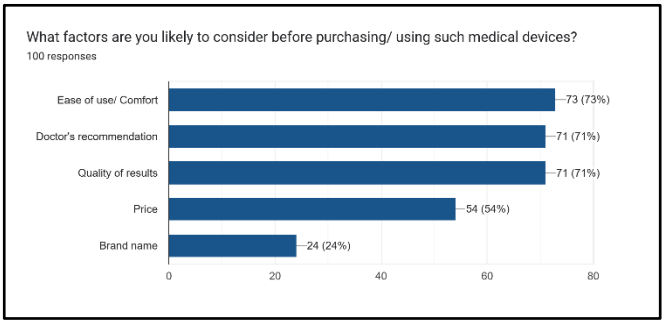
Perceived benefits of IoT based connected medical devices

When asked about what benefits the consumer perceives, that such medical devices can provide, 72% feel that such devices are better for fitness tracking and save time for check-ups.

About 50 to 65% of the respondents believe that such medical devices help in disease management and minimize the number of hospital visits due to health monitoring at home. Less than 40% of people think that utilizing such medical devices and technology, will reduce the risk of exposure to outdoor Covid19 infection, minimizing consultation costs, and medication management. It is notable that very few people are aware that such medical devices can provide a seamless transfer of patient vitals data.

Factors that influence buying decisions

The Chi- square analysis depicted that there is a significant relationship between the location of the respondent (tier1 or tier 2 cities) and awareness of the devices due to the Covid19 pandemic.



Graph 2: Factors influencing purchase or usage decision of consumers

Interpretation: More than 70% of the respondents give priority to the Doctor's recommendations to use connected medical devices, Ease of use of the device, and Quality of results. Interestingly, Indian consumers being price sensitive, respondents give low priority to price and brand name because these devices are the products benefitting the health of the consumers.

Spearman Correlation for hypothesis testing

This Spearman correlation test is for testing the relationship between two sets of ordinal variable data.

Correlations

			How aware are you of the internet- connected medical devices that share patient vitals / test result with doctor?	How likely do you intend to buy/ use such medical devices in the future?
Spearman's rho	How aware are you of the internet- connected medical devices that share patient vitals / test result with doctor?	Correlation Coefficient	1.000	.577**
		Sig. (2-tailed)	.	<.001
		N	100	100
	How likely do you intend to buy/ use such medical devices in the future?	Correlation Coefficient	.577**	1.000
		Sig. (2-tailed)	<.001	.
		N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 1 (a): Spearman correlation test for hypothesis testing

Confidence Intervals of Spearman's rho

	Spearman's rho	Significance(2-tailed)	95% Confidence Intervals (2-tailed)[a,b] Lower	Upper
How aware are you of the internet- connected medical devices that share patient vitals / test result with doctor? - How likely do you intend to buy/ use such medical devices in the future?	.577	<.001	.424	.698

a. Estimation is based on Fisher's r-to-z transformation.

b. Estimation of standard error is based on the formula proposed by Fieller, Hartley, and Pearson.

Figure 1(b): Correlation between awareness and customer buying intention

Interpretation: Figure1 (a) shows that the significance p-value is less than 0.001 (less than alpha= 0.05) meaning we can reject the null hypothesis. It also shows that the correlation coefficient is 0.577, which is positive. Figure1 (b) shows the Spearman correlation (rho) is positive, this indicates that there is a positive correlation between awareness of IoT-connected medical devices due to Covid19 and the intention of consumers to buy/ use these medical devices. This means that if awareness increases, consumers' intention to purchase or use such devices is likely to increase.

Hypothesis Test Result:

We reject the null hypothesis and accept the alternative hypothesis. Therefore, it is evident that there is a significant relationship between 'Becoming more aware of the IoT-based connected medical devices due to COVID19 pandemic' and 'Intention to buy or use IoT- based connected medical devices due to COVID-19'.

5.2 Doctor survey analysis

The sample size of the doctor survey is 10. The collection of this survey data included approaching the doctors in the hospitals or online, sharing the survey with them, and understanding their perception of IoT-based connected medical devices and technology.

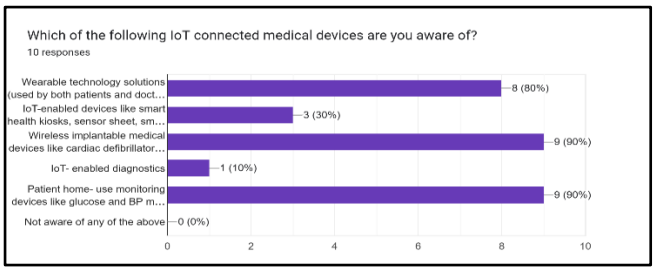
Demographics:

The doctor respondents were from the departments related to general/ internal medicine and surgery, outpatient department, and community medicine. About half of the respondents were female and half were male. 7 doctor respondents belong to Tier 2 cities and 3 belong to metropolitan cities.

Awareness of IoMT applications and connected medical devices:

Nine out of ten doctor respondents are aware of the IoT applications in healthcare. All the 10 doctor respondents are aware of telemedicine. 6 doctors were aware of remote patient monitoring whereas 5 were aware of medication management and data collection. Interestingly, only 2 respondents were aware that IoT technology can help in tracking the sudden changes in patients' vitals and alert systems like smart beds, and health kiosks.

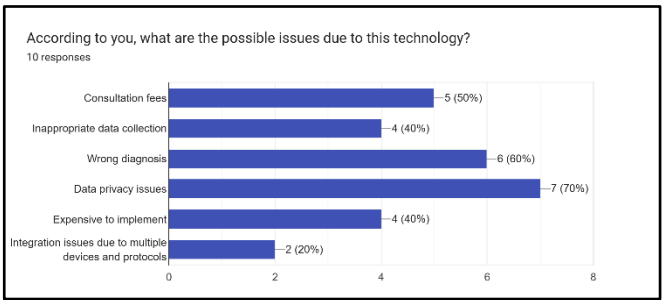
Most of the doctors also think that telemedicine is mostly useful during Covid19 or for non-emergency patients and follow-up patients to save time and provide quick access to services. When asked to rate their preference of telemedicine to physical consultation, 6 out of 10 doctors' response was neutral. This indicates that there is lack of habit or lack of awareness about how telemedicine is important in future for both the patients and doctors, not only in the pandemic. The hesitation to adopt such technology also plays major role.



Graph 3: Awareness of doctors about the categories of IoT connected medical devices

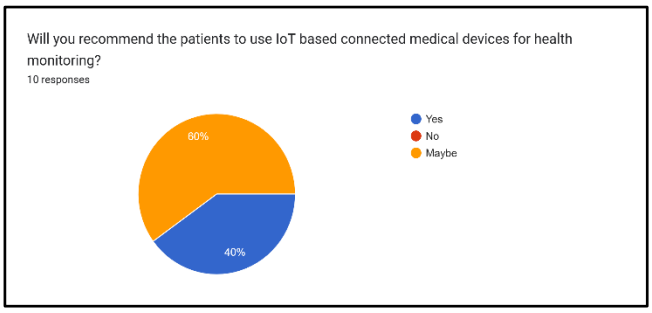
It is notable that there is a lack of awareness of IoT-enabled devices like smart beds, health kiosks, etc and IoT-enabled diagnostics that transfer MRI CT data seamlessly to EHR systems. When asked about the benefits of IoT technology in healthcare, only 3 out of 10 doctors are aware that IoMT technology helps in improving clinical workflows and reducing turn- around times.

Perceived barriers in adopting IoMT (Internet of Medical Things):



Graph 4: Perceived barriers

More than 6 doctors think that there is a high risk of data privacy issues due to sensitive patient EHR data and confidentiality breaches, and the risk of the wrong diagnosis due to misrepresented data. Other perceived barriers are inappropriate data collection, irregularities in consultation fees, and the high cost of implementation. It is notable that there is a lack of awareness and perception about the integration issues due to multiple devices and protocols.



Graph 5: Whether doctors will recommend IoT based connected medical devices to patients

Interpretation**:** 6 out of 10 doctors are not sure whether they are likely to recommend such medical devices to patients and only 4 doctors said they will recommend them. This indicates that there is a lack of in-depth awareness about IoT technology applications among doctors.

6. Recommendations and Conclusion

The following recommendations intend to enhance in-depth awareness of such medical devices among both consumers and healthcare providers:

1) Developing public education campaigns on the internet, social media, and public media, as well as in hospitals, will be fruitful in increasing the in-depth awareness of IoT-based connected medical devices and their benefits.
2) The healthcare providers with IoT systems and medical device companies in India should work on enhancing the functionality and usability of the connected medical devices to attract Indian consumers.
3) Hospitals and the practicing doctors who are in regular and continuous contact with the patients will be far better catalysts in increasing the awareness and influencing the buying decisions of connected medical devices. The study indicates that, in this digital age, consumers trust doctors and are likely to act based on their advice. Hospitals should organize regular technology upskilling courses and workshops to help doctors stay informed about the latest trends in the healthcare sector.
4) Hospitals can also display patient testimonials highlighting the use of IoT-based connected medical devices to enhance awareness and foster trust among consumers.
5) The Indian consumers themselves need to spread awareness about IoT-based medical devices, especially the younger generation who have access to and resources to gain knowledge about such devices.
6) From the hypothesis testing, it is notable that, as consumer awareness about IoT medical devices due to the COVID-19 pandemic increases, there is a high probability of their intention to buy such medical devices. Adopting the mentioned recommendations will also prove productive in expanding the IoMT and medical devices market potential in India.

Acknowledgement
I would like to express heartfelt gratitude towards my mentor Dr. Rohan Kesarkar for his valuable suggestions, feedbacks and encouragement. I appreciate his constant support through all the stages of the research. I am also thankful for the learning opportunities provided by WeSchool.

Conflicts of Interest: None declared.

References

[1] *View of consumer buying behaviour on healthcare products and medical devices during COVID-19 pandemic period – A new spotlight*, NVEO - Natural Volatiles & Essential Oils Journal, vol. n.d., pp. 1–15. Available: https://www.nveo.org/index.php/journal/article/view/2765/2361
[2] *Review on people's trust on home use medical devices during Covid-19 pandemic in India*, ResearchGate, Feb. 2022. Available: https://www.researchgate.net/publication/358802313
[3] *ANN model for users' perception of IoT-based smart healthcare monitoring devices and its impact with effect of Covid-19 pandemic*, ResearchGate, 2021. Available: https://www.researchgate.net/publication/350581471
[4] *Home-use medical devices (glucometer and blood pressure monitors): A survey of OPD patients on awareness, usage, and buying behaviour determinants*, ResearchGate, Apr. 2022. Available: https://www.researchgate.net/publication/354919795
[5] *WelingkarRemoteLog*, Shodhganga. Available: https://shodhganga.inflibnet.ac.in.welingkar.remotlog.com/handle/10603/286971

[6] *Patients' attitudes toward the use of IoT medical devices: Empirical study*, Sciendo, Apr. 2022. Available: https://sciendo.com/pdf/10.2478/picbe-2019-0050
[7] *Shift in consumer behaviour will change the game for the industry*, LiveMint, Apr. 2022. Available: https://www.livemint.com/technology/tech-news/shift-in-consumer-behaviour-will-change-the-game-for-the-industry-11597365588879.html
[8] F. Healthcare, "Transforming cardiac care in India with technology," *Financial Express*, Feb. 16, 2022. Available: https://www.financialexpress.com/healthcare/healthtech/transforming-cardiac-care-in-india-with-technology/2435928/
[9] *Internet of Medical Things market to reach US$ 284.5 billion by 2027 globally*, PR Newswire, Apr. 2022. Available: https://www.prnewswire.com/in/news-releases/internet-of-medical-things-market-to-reach-us-284-5-billion-by-2027-globally-cagr-18-5-univdatos-market-insights-50218832.html
[10] *A global view of how consumer behavior is changing amid COVID-19*, McKinsey & Company, Apr. 2022. Available: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Marketing%20and%20Sales/Our%20Insights/A%20global%20view%20of%20how%20consumer%20behavior%20is%20changing%20amid%20COVID%2019/20200707/covid-19-global-consumer-sentiment-20200707.pdf
[11] Consumer Survey response of google form Available: https://docs.google.com/forms/d/1ROgyaHZDAoPE4s_RInAIdCrRJT7gzFTVfUwLHpS8P9M/edit#responses
[12] Doctor Survey response of google form Available: https://docs.google.com/forms/d/1FjbJZd4nGfW4KSLyZqyMbop27L_UITN4kwTdAAECGpg/edit

Author Profile

Sarvesha Marathe, B.E Computer, Student of PGDM Healthcare at Prin. L. N. Welingkar Institute of Management Development and Research, Mumbai, India. She is now, Healthcare Business Analyst, CitiusTech

Dr. Rohan Kesarkar, PhD, Assistant Professor (Healthcare Management & Business Design), Prin. L. N. Welingkar Institute of Management Development and Research, Mumbai, India. He is now, Assistant General Manager, USV Private Ltd.