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Review Article

An extensive study on Internet of Behavior (IoB) enabled Healthcare-Systems: Features, facilitators, and challenges

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ABSTRACT

The Internet of Behaviour (IoB) is an effort to dissect behavioural patterns as explained by data collection. IoB is an extension of the Internet of Things (IoT). Therefore, both are anticipated to experience exponential growth in the upcoming years. Healthcare firms have many opportunities to employ IoB to provide individualised services and anticipate patients' behaviour. As behaviour and analysis are closely related to psychology, many techniques exist to collect relevant data. The IoB improves the doctor's and patient's experience. As IoT and IoB are interconnected, IoB technology collects and analyses data depending on user activity. These offer a practical technique for developing real-time remote health monitoring systems. This technology aids in the optimisation of auto insurance premiums in the healthcare sector. It tries to alter patient behaviour in order to improve the treatment process. IoB has applications in various areas, including retail and entertainment, and has the potential to change the marketing sector significantly. This technology is helpful for the appropriate analysis and comprehension of behavioural data used for creating valuable services for treatment. The primary purpose of this paper is to study IoB and its need for healthcare. The working process structure and features of IoB for the healthcare domain are studied. This paper further identifies and analyses the significant applications of IoB for healthcare. In the future, IoB technologies will give us a higher quality of life and well-being. IoB is the ideal fusion of technology, data analytics, and behavioural science. This will help healthcare professionals collect data and analyse the patient's behaviours for an efficient treatment process. The IoB will be the digital ecosystem's intelligence in a few years.

1. Introduction

The Internet of Things (IoT) leads towards the Internet of Behavior (IoB). IoT's typically referred to as a network of physical items implanted with sensors, software, and other technologies to connect and exchange data with other systems and devices over the Internet. IoB is considered one of the cutting-edge technologies that the world is currently experiencing. The IoB gathers information on how devices are used to learn more about user behaviour, interests, and preferences. IoB attempts to comprehend user online activity data from a human psychology perspective. This technology assists in identifying patterns and recommendations for customer behaviour [1–3]. Companies are now capable of knowing customer needs. IoB data collection will aid in understanding consumer behaviour and patterns. IoB firms aid in campaign optimisation and enhance client satisfaction. This technology collects data from sensors, devices, geo-tagging activities, cookies, browser histories, social media activity, and other sources [4,5]. These data are used for several analyses to predict consumer behaviour and needs.

Data security issues are common and may expose personal data such as health status or medical history. Identity theft, online fraud, and technology theft are increasingly common in the IoT-enabled ecosystem. It is also possible to get sensitive information like delivery routes and banking codes using IoB. Businesses may use deception to get customers to spend more money on certain products. Using consumer data or private information may give rise to privacy problems due to a need for more data regulation in the online sphere. Customers will benefit from a personalised experience using IoB. As a result, relevant information, offers, prices, discounts, and more will be displayed along with suggested adverts. In order to interact with clients in real time, the IoB is considered an essential tool. It accomplishes this by offering

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pertinent information about the customer while they are preoccupied with their product or service search [6–8].

Companies and organisations that successfully navigate the difficulties of establishing and maintaining an IoB system might benefit. The major challenge in IoB adoption is gathering private information from customers and employees. People are reluctant to give some personal information for ease and other advantages. Businesses can learn more about their customer's preferences and buying behaviours based on how they use various platforms and devices [9,10]. Therefore, customers will be able to solve their problems quickly, resulting in a pleasant customer experience. We can predict and enhance individual behaviour using IoB. Leading companies have admitted to exchanging customer information with other companies without the customer's consent. IoB establishes a digital link between people's behaviour and activities, allowing precision targeting and delivering information and services to affect behaviour. When it comes to addressing individual and situational needs, it is intended to secure fast, relevant, and accurate communication, offerings, and services better than any Artificial Intelligence (AI)/Machine Learning (ML)-based system can [11,12].

Digital transformation technologies significantly impact several industries, and healthcare is one of them. The IoB is gradually displacing the discussions around IoT development, AI, and robotics technologies utilised in the healthcare sector. The IoB will be utilised in the healthcare sector to track patient behaviour and related activities regarding disease and its treatment. They will be monitored to ensure the task is completed on the prescribed schedule [13,14]. IoB is more than simply data analysis; when combined with effective digital marketing methods, it may significantly increase medical product sales with digital marketing. Users of digital tracking do not object when the information supplied gives value to their daily lives, making it the best choice to research market trends before introducing a product. This technology can also persuade a consumer to purchase a product. For instance, smartwatches that monitor a user's heart rate, blood pressure, sugar levels, water intake, physical activity, and other data analyse lifestyle errors and recommend a better way of living. The IoB requires an internet connection to function; therefore, digital services will be among the healthcare that benefits most from this technology [15–17]. Therefore, this study discusses the significant capabilities of IoB in healthcare.

2. Internet of behavior

The term "Internet of Behavior" refers to the gathering and application of data to influence behaviour. These data are gathered by electrical appliances, personal internet activities, and wearable technology, and they can provide essential details about user behaviour and preferences. IoB is an extension of IoT that entails using data gathered from IoT devices to use feedback loops to affect customer actions and behaviours. It is based on an understanding of human psychology, such as making purchases, adhering to a particular online brand, or tracking and analysing those behaviours utilising smart technology and machine learning algorithms. The IoB is a body of data that contains vital information on consumer behaviours, interests, and preferences. The IoB attempts to comprehend data obtained from users' online behaviours from a behavioural psychology standpoint. It aims to solve the issue of how to comprehend data and utilise that knowledge to develop and advertise new goods from the perspective of human psychology [18–20].

The "IoB" refers to a method for user-controlled data analysis based on behavioural psychology. The research has an influence on user experience, search experience optimisation, and how final products and services are marketed and promoted by a corporation. In addition to technical complexities, IoB is also challenging psychologically. For ethical and regulatory reasons, it is essential to undertake statistical studies that record usual routines and behaviours without entirely compromising client privacy. Data analytics, behavioural science, and artificial intelligence are all combined to study human behaviour through data mining. IoB seeks to find methods to turn knowledge gleaned from internet user activities into something useful. Because it may provide a thorough and customised knowledge of the clients, IoB has the potential to become an efficient marketing tool for businesses all over the globe. This technology is helpful for the healthcare industry in delivering individualised care [21–23].

3. Need of IoB in healthcare

There is a need for IoB in healthcare to perform daily operations, including treatment planning, operations scheduling etc. IoB assists in determining the primary influencing aspects of a patient's behaviour. IoB also assists buyers in obtaining their desired services without wasting time navigating various purchasing methods for healthcare. Additionally, this technology can assist firms in developing goal-driven plans to delight clients and increase sales rates by analysing data [24,25]. This innovation will fundamentally alter consumer purchasing behaviour and could revolutionise how goods are purchased. Many users are happy to share their personal information, even though some are hesitant to do so unless it adds value to their treatment services. Data from every aspect of a user's life may be gathered to improve performance and quality. This enables numerous touchpoints for the customer to interact with [26,27].

A large amount of data that can influence or drive patient behaviour are gathered through IoB. By examining online user behaviour, it seeks to comprehend user psychology. This framework can gather, examine, comprehend, and react to various human activities through machine learning algorithms. Many firms have been able to use online advertising to reach more clients by implementing IoB technologies. Businesses may quickly identify and target particular people or groups to offer their services and products using IoB. For instance, Google and Facebook use behavioural data to show their consumers relevant advertisements. With IoB, businesses may track customer behaviour to provide better services while connecting with potential customers [28–30].

4. Research objectives

The goal of IoB is to predict and alter behaviour using data. IoB implementation varies depending on the industry. Real-time workload and delivery schedule management are significant benefits of IoB [31,32]. IoB prioritises gathering, analysing, and comprehending user behaviour to enhance the value chain and service quality. With the help of this technology, behavioural science can provide more significant insights from the data. Additionally, as IoB ensures two-way communication with clients, it aids in improving customer relationships. Instead of doing surveys to gather feedback from clients, businesses can much more effectively identify their needs and offer a beneficial upgrade [33–35]. The primary research objectives of this article are as under:

RO1: - to study IoB and identify its need for healthcare;

RO2: - to study the working process structure of IoB for the healthcare domain;

RO3: - to discuss the various considered features of IoB for the healthcare sector;

RO4: - to study and identify major applications of IoB for healthcare.

5. Working process structure of IoB for the healthcare domain

The process of IoB started with the fundamentals of IoT in terms of data flow and information sharing. This concept has gained attention while targeting the improvement in serving the customers of the numerous services. Fig. 1 depicts the process and working structure of IoB philosophy towards updating and supporting the healthcare sectors. Knowledge with improved and enhanced wisdom is an integral part of this process flow of the IoB theme [36–38].

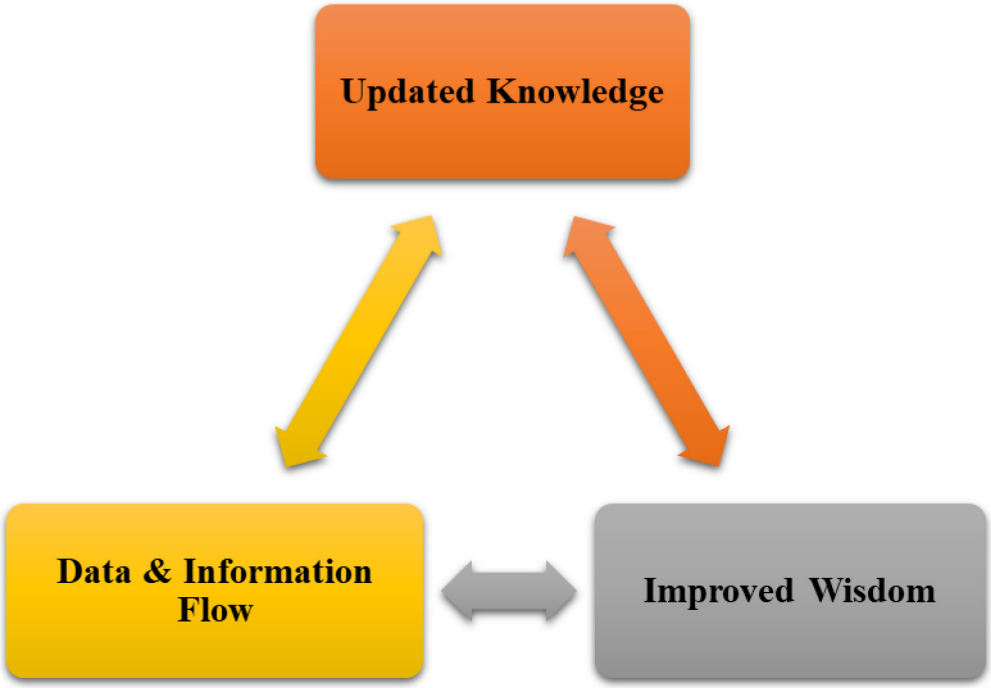

Fig. 1. Smart process structure of IoB for healthcare.

The IoB helps users, particularly those working in retail, healthcare and consumer industries, to understand the demands and preferences of their customers. IoB, applications help observe consumer needs and preferences, especially organisations, to navigate the crisis with minimal collateral damage if it understands its target audience. As a result, the introduction of the internet and social media marketing has substantially changed how client behaviour is approached and studied. This brings us to the IoT, a network of connected devices used for data management and sharing [39–41]. The IoT helps turn data into information, whereas IoB translates this information into valuable knowledge. Many companies have shifted to using social and digital media to sell their products during the pandemic. The IoB is considered one of the crucial tools for organisations looking to improve their online visibility [42,43].

Although the IoB is still developing, it has numerous advantages for healthcare. It aids marketers and business owners in thoroughly understanding their target market. Understanding online behaviour will improve the client experience. The IoB is concerned with gathering, analysing, and utilising information on human behaviour to modify it positively. With the emergence of social media, consumer analytics and targeted advertising have increased dramatically [44,45]. Companies may now easily reach their target audience where they are already spending time through social media. The popularity of IoT devices will undoubtedly encourage the use of IoB, much as the smartphone boom contributed to the growth of social media. Cybercriminals may be able to acquire private information about consumer preferences and gather market access codes, delivery routes, and bank codes using behavioural data. The IoB has the potential to be an effective new sales and marketing tool for companies and organisations. Digital marketing is among the many fields and ways of doing business that is being radically altered [46–48].

Based on information gathered from various social media and other platforms, the IoB investigates consumer behaviour. The information gathered will be used to make assumptions about the lifestyle of the consumers. These gadgets provide online suggestions to users about services and products. It is also helpful to examine the car's speed, braking, acceleration, and other factors to determine how cautious the insured driver is using the data from IoT tracking devices [49–51]. The corporation lowers the premium the customer must pay after collecting data for a predetermined time if the user's behavioural data demonstrate fewer risk characteristics. The same information can be used to enforce safe driving habits and to evaluate a claim in the event of an accident. With the aid of IoB, healthcare may revolutionise its operational efficiency. In actuality, it was the industrial firms that popularised IoB during the Covid-19 pandemic [52,53].

Several protocols are developed and applied in the current healthcare industry, and these protocols are well adopted with the help of IoB. For instance, employees and visitors are continuously observed by computer vision to ensure that they are wearing masks properly. The other protocols' compliance was also checked using similar sensors. Therefore, automated alerts are sent anytime there seems to be a safety breach to guide them to the proper behaviour. IoB applications can guarantee better working conditions, increased productivity, and increased employee satisfaction in different sectors, including healthcare. The IoB offers valuable information on client behaviours, interests, and preferences [54,55]. The IoB aims to get user online activity data from a behavioural psychology standpoint. It addresses the issue of how to comprehend the data and use that information to develop and advertise new products from the human psychology perspective. IoB is a valuable method for analysing user-controlled data from behavioural psychology. Although IoB technology combined with IoT-harvested data can be used to market, not all of it is focused on advertising. Organisations will be able to evaluate, for instance, the effectiveness of both their for-profit and nonprofit efforts. Healthcare professionals can also track their efforts to engage and activate patients to improve their health [56,57].

6. Various considered features of IoB for the healthcare sector

Fig. 2 explores the several considered smart features and traits of IoB practice towards strengthening the healthcare systems. As reflected in Fig. 2, this concept involves the precise flow of information, which is further evolved with smart connectivity for processing patients' data effectively. This process is digital in its procedure and becomes quicker and faster, which ultimately results in empowered patients [58,59].

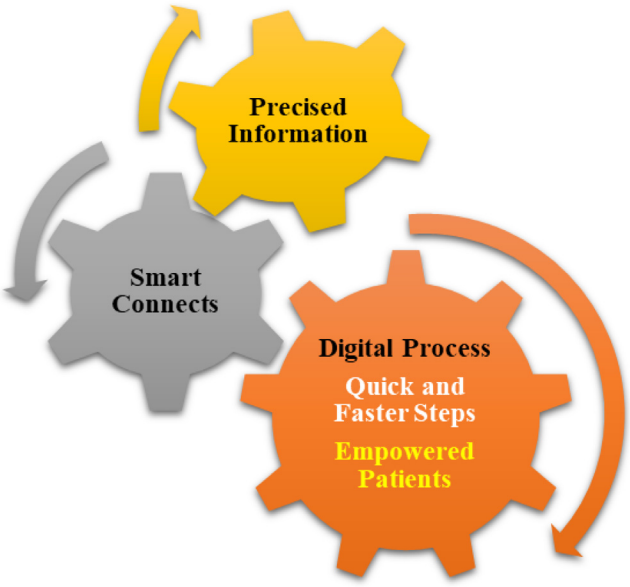

Fig. 2. Different considerations of IoB for healthcare systems.

Technology has advanced to the point that the term "IoB" uses data gathered by the IoT. First, IoB is applied to assessing adherence to health practices. IoB delivers comprehensible and practical advantages. Cybercriminals are particularly capable of utilising behaviour data. As a result, businesses need to be more alert and proactive in their data protection and maintaining privacy. Businesses gather and examine data for several purposes. This comprises, among others, guiding user experience design, generating products and services, aiding businesses in making informed business decisions, and tailoring marketing strategies [60,61]. Another element of the IoB is combining and evaluating data from various sources to reach a better and more efficient decision. Integrating IoT and IoB is seen as promising digital technologies that will soon become more practical in several domains. Even at an early stage, the benefits and potential of IoT solutions when integrated with IoB technology are clear. Even though IoB is still in its infancy, the IoT and its extensions will become essential in people's lives in the upcoming years, making life much simpler and more effective. It may develop into an ecosystem that defines the attitudes and behaviours that govern the digital world [62,63].

The world is now digitally capable of performing businesses and daily activities. The daily upgrades brought on by digital changes completely alter how businesses operate, and people live. It is also among the most popular technologies because it has fundamentally altered how devices are connected. IoB interprets information in light of particular human behaviours, such as purchasing habits and demographic interests. The IoB interprets the data gathered by IoT in conjunction with certain human behaviours, such as purchasing trends and community interests. Customers' behaviour when using maps is mainly influenced by devices connected to geolocation, big data, and facial recognition. IoB relies heavily on these data, yet it hides how consumers' data is gathered. Tracking their geographic location may determine whether someone has visited a store and how long they stayed there. Accordingly, companies can send out marketing messages, offers for promotions, and discounts to boost sales and give customers an outstanding shopping experience [64–66].

The IoB is used to modify how product marketing is done and obtain a fresh perspective on search experience optimisation or building design using the results of data analysis. The IoT is used with IoB since all data gathered from IoT and other sources are utilised to influence consumer behaviour. IoT technology gathers much data about interests and how to use items by connecting a phone with a laptop, voice assistant, or smart home. The tourism sector was another area where IoT and IoB significantly impacted [67,68]. Applications for making reservations can learn from past searches and other indexes, including demographic or social status data. It provides the most appropriate travel advice for customers. Data from numerous sources is analysed using e-commerce to learn more about customer behaviour. IoB enables researchers to understand how consumers first gained interest in a product and what factors influenced their purchasing decisions. This technology offers industry insights that enhance the proposals for the customers' demands [69,70].

Logistic IoB can be used for delivery planning, route, and correct route recommendations based on real-time data from various sensors. Telematic solutions are examples of the IoB. For instance, managers might use sophisticated car data to plan strategic routes. Additionally, this information may include details about a driver's behaviours, current information about accidents along a route, the sort of delivery to determine the most specific course, and logistics. The world is currently experiencing the emergence of the IoB and the IoT. The IoT and other sources are utilised to gather this data, which is then put to good use. It could provide insightful data on user preferences and behaviour. Gathering, analysing, understanding, and responding to various behaviours is the main objective of the IoB, which aims to improve the customer experience. Additionally, behavioural data enables firms to make better decisions regarding customer preferences and their experience. It also improves the value chain and the quality of the services. There are several locations where consumers may get information [71–73].

The IoT has now been expanded to include the IoB, where information is gathered from several connected devices to gain insightful knowledge about client interests, behaviours, and preferences. IoB aids in collecting, understanding, assessing, and assembling all forms of human behaviour. This aids in comprehending recent advances in technology and ML techniques. IoB is a potent instrument for boosting sales and developing exciting marketing campaigns. The IoB has attracted attention from all across the world. The IoB, like the IoT, may profoundly impact how people live. This technology can open up new technological frontiers [74,75].

7. IoB applications for the healthcare sector

IoB offers predictive data on any objectives and plans relevant to the current circumstance in healthcare. The IoB transforms into a tool for precise forecasting when it has significant users. This sets it apart from other apps that seek to track people's movements, find their locations, identify their faces, and determine their proximity to one another. However, combining these strategies can provide a very potent, situationally intelligent service. Modern tracking apps can incorporate IoB to capture the users' location [76–78]. The complexity of IoB is continually growing and changing, including how devices are connected, what calculations they can perform on their own, and how data is stored in the cloud. The transition to mobile devices has altered how individuals interact with one another and the outside world. The IoB devices' usage data provide valuable details on users' interests, actions, and preferences. Healthcare professionals can suggest a behaviour change programme for those conditions that can be prevented while IoB technology tracks progress along the way. Early detection via linked devices enables medical practitioners to start treatment earlier, even for non-preventable diseases; this relieves pressure on health systems and prolongs patient lives [79–81]. Table 1 discusses the significant applications of IoB for healthcare.

IoT devices collect usage and behavioural data, which offers insights into users' behaviours, interests, and preferences. Businesses are consequently putting more emphasis on IoB to collect such data for marketing and advertising purposes. The only real differentiator in today's commoditised world is in services, and IoB empowers businesses with superior servicing capabilities [82–84]. Both online and

Table 1
IoB application areas for the healthcare sector.

S No	Applications	Description
1.	Health-tracking	IoB is used to create health-tracking smartphone apps that measure a user's food intake, blood sugar levels, heart rates, and sleep patterns. However, they do have big plans for IoB technology. They want to make it simple to keep track of how they behave throughout the treatment. Companies that have access to the data IoT provides about us can now use IoB data to affect our behaviour. The app can alert to potentially hazardous situations and suggest behavioural modifications that result in a more advantageous or desirable outcome. A company's website, social media profiles, sensors, telematics, beacons, health monitors, and several other devices are a few of the places where consumer data may be obtained. IoB provides businesses in a wide range of sectors with innovative ways to sell their goods and services, enhance the value of their offers, and affect consumer and employee behaviour. Based on the data gathered, the technology enables them to increase the value of their relationships with clients and suppliers and improve financial results. Understanding behaviours through data will become an exciting component of every business as new IoT devices proliferate.
2.	Healthcare insurance	The adoption of IoB can benefit healthcare insurance as well. In particular, analysing consumer behaviour using data from IoT devices can aid in a more accurate estimation of insurance costs. Additionally, health insurance providers can utilise IoB to monitor clients' physical activity levels and determine how much to charge for premiums. IoB has the potential to be very helpful in the health insurance sector. Insurance firms monitor and secure motorist behaviour using driver-tracking software. Using IoB, they may assess the behaviour and decide whether a specific event resulted from an accident or an insured's mistaken assumption. Insurance providers now have a new potential to offer customised rates based on user-driving behaviour using the IoB. IoT devices can track the speed and distance of a car, typically used for driving, and offer the appropriate premium insurance. IoB aids in locating the target auditory that is the most precise. This is the fundamental tenet of the algorithms used by those businesses to guarantee that customers receive pertinent information. Monitoring straightforward visible actions by current digital technology has clear benefits for entertainment, sports, health, and life-coaching apps. The behavioural loop is incorporated right into Spotify, which is interesting since it allows users to communicate their desires and be rewarded with appropriate music whenever they want. IoB might also be used there to achieve a lot more.
3.	Determine health procedures	The role of the IoB is introduced in healthcare. In order to determine if health procedures are being followed during the continuing COVID-19 pandemic. Furthermore, due to the COVID-19 pandemic, tiredness, a condition when individuals relax their adherence to public health precautions, the usage of IoB in medical devices, for this reason, will become more crucial than ever. Additionally, IoB uses thermal imaging to help detect people who have a fever. IoB can be a potent tool for combining sales and marketing to develop strategies that improve the products and services given to customers. IoB, for instance, is helpful in the medical industry since it enables medical professionals to evaluate patients' illnesses, responses to medicines, and other information about their way of life. Most location-based services track the user's location and send emails or notifications according to the GPS functionality of their mobile device or other methods like Bluetooth and near-field communication. Additionally, gathering information in real-time rather than after a delay aids businesses in making quick modifications/updations to their product offers.
4.	Assess patient activities	Healthcare practitioners may assess the extent of patient activity and participation. IoB may be used to assess how well healthcare activities are working. Organisations can use it to monitor staff compliance with pandemic health precautions such as mask wear, fever testing, and hand washing. Healthcare practitioners may also employ smart devices to monitor people's activities or whereabouts to ensure they are lowering their risk of contracting the virus by following social restrictions. IoB is, therefore, relevant to the well-being of the populace as a whole. IoB offers other advantages like a better comprehension of how consumers engage with items, improved insight into buying habits, real-time help, and customer communication in previously impractical ways. The IoB concept also centres on the appropriate analysis and comprehension of behavioural data and the aim to use knowledge to develop and market personalised goods and services that will be more valuable to customers and enterprises. Businesses and other organisations are heavily utilising this technology to increase their profits. By offering goods and services that are more suited to their needs and preferences, the IoB will also benefit customers.
5.	Wearing mask detection	Many computer vision businesses started employing IoB to detect whether citizens wore masks during the outbreak. Thermal fingers were employed to identify patients with elevated body temperatures in the same instance. IoB is helpful for face recognition to identify its customers' gender, age, and mood. In tailored advertising, the same system can perform admirably. Many digital marketing organisations currently employ analytics software to learn about consumer behaviour. The IoB allows marketers to reimagine the value chain, access previously inaccessible data, evaluate customer purchase patterns across platforms, and even deliver customised adverts and real-time point-of-sale notifications. Businesses can gain a deeper understanding of consumers' opinions towards particular goods or services, making it even simpler to address customer complaints. Sensors and RFID tags are already being used by businesses in the manufacturing sector to monitor how frequently on-site workers wash their hands. Additionally, computer vision can identify whether or not workers are adhering to social distancing instructions or mask procedures. Healthcare professionals can monitor patients' efforts to engage and activate.
6.	Disease surveillance	IoB is an effective tool for many different sectors. Disease surveillance, targeted shopping advice, car tracking for insurance, and fleet management are all made possible with this technology. People can use IoB applications to increase their effectiveness and satisfaction with goods and services. IoB focuses on using data analytics to change people's behaviour. Examples of the IoB applications that are ingrained in our daily lives include sensor-led driver assistance systems that advise safe driving techniques and health apps on our phones that track our diet, sleeping patterns, heart rate, blood glucose levels, etc. and suggest "habit alterations." Homes can become incredibly smart by using IoB. Earlier, we could use a smartphone or tablet and an Internet connection to remotely control appliances, thermostats, lighting, and other devices. Now, all the functionality of smart homes will automatically adapt to our preferences using information about our behaviour patterns previously collected by our devices. Though IoB has a good impact on our lives because it guides us in many areas, we should be aware that the system collects personal data and that the businesses that hold it bear much responsibility. The IoB concept entails changing our cultural norms and regulations established before the Digital Ages to transform our data into valuable knowledge about our decision-making patterns.
7.	Fitness tracking	Fitness tracker data is currently being used extensively to advance the healthcare sector. Big data is reviving the interaction between the sectors of health and fitness, two related fields. The industry benefits from all the information about people's lifestyles, health practices, fitness levels, and diets. However, users also benefit from the reminders and encouragement provided by the notifications that fitness trackers send out regarding things like calories, heart rate, blood pressure, and sleeping patterns. IoB devices are improved with embedded software and various sensors that collect data produced by people. Sensor data can be saved and analysed on a device or the cloud, depending on the device's computing power. Wireless body area networks can incorporate intrusive and wearable IoB device networks, which can be hybrid or wireless. IoB systems can safely exchange data in real time or at predetermined intervals with a central hub using connectivity technology. While the sensor data gathered by a smartwatch can offer insightful information about a patient's past, present, and future health concerns, the IoT also provides several non-invasive and highly effective diagnostic techniques. A stylish wearable device worn at the bottom of the ribcage can track lung function and detect early anomalies. Additionally, doctors can diagnose genetic abnormalities and treat diabetes more effectively by analysing data gathered by wearable sensors.

(*continued on next page*)

Table 1 (*continued*).

S No	Applications	Description
8.	Better healthcare solutions	The applications of IoB apply to every industry and sector. For instance, doctors might recommend better healthcare solutions to patients using data from wearables or healthcare applications. Patients with serious illnesses particularly benefit from it since IoB can monitor and spot irregularities, alerting concerned parties in real time. IoB hazards and advantages might be thoroughly researched and made publicly available as a solution to address various issues while removing marketing hype. In addition to addressing data privacy concerns, closer cooperation between regulators and device manufacturers may also lower the cost of IoB products. The IoB provides crucial information about consumer behaviour, interests, and passions. IoB uses behavioural psychology to try to make sense of the information gathered from user interactions online. IoB also uses available personal technologies like face recognition, location monitoring, and Big Data. As a result, it combines technology, data analytics, and behavioural psychology elements. The IoB's goal is to record, examine, comprehend, and react to all human activity in a way that enables tracking and interpreting of people who use cutting-edge technologies and advances in machine learning techniques.
9.	Analyse physiology	Most trackers or wearables make recommendations based on a comparison of baseline readings. The IoB can help when it comprehends the person's physiology thoroughly. IoB can assist with additional research in addition to providing particular recommendations. IoB allows for more excellent data collection and analysis of human behaviour in the actual world. IoB eliminates uncertainty about improving customer experience, increases the effectiveness and calibre of marketing campaigns, and alters how businesses interact with their customers by giving them priceless insights into user behaviour and the psychological factors involved in decision-making. Businesses can innovate to grow their companies by utilising the IoB. IoB will undoubtedly be at the forefront of creating new experiences for the global community. Currently, organisations use IoB to assist direct behaviour towards the desired results. It could be used to promote desired behaviour at work. For instance, firms may utilise computer vision to determine whether personnel are wearing masks or thermal imaging to monitor a rise in body temperature to ensure that the current health procedures are being followed. Similarly, sensors and RFID tags can track other hygiene practices like hand washing and space sanitisation.
10.	Analyse health conditions	Networked devices keep an eye on a person's health, gather physiological, biometric, or behavioural data, and communicate with one another across a wireless or hybrid network. The IoB cohort can also include independent mobile applications that examine physical activity and health-related information, including heartbeat, blood pressure, and sleep patterns. The IoB involves gathering, analysing, and interpreting data from IoT devices to spot trends in user behaviour and use this understanding to trigger specific behavioural events. These efforts improve business outcomes, such as increasing sales by effectively communicating with the relevant audience. Deeper behavioural insights are available as more devices are online. Additionally, businesses are likely to reward customers financially for opening up about their habits, way of life, preferences, and even dreams. IoB eliminates the requirement to create a perfect user persona. Big data enables the examination of prospective clients from multiple angles. One can create an extraordinarily detailed map of their customer's journey, use a highly tailored strategy, and add more points of contact. Users will use voice interaction with gadgets more frequently, moving in the direction of natural language and intent-based search.
11.	Customised treatment and medication	IoB devices could aid medical personnel in spotting repeating trends in patient data and developing customised treatment and medication regimens catered to the requirements of a particular patient or patient group. For this reason, electronic health records could be enhanced with sensor data and subjected to artificial intelligence algorithms analysis. Health insurance businesses can adopt a more detailed approach to risk profiling and optimise insurance policies based on a person's medical history, occupation, and lifestyle. IoB devices can measure several bodily data, such as cardiac rhythms, sleep patterns, menstrual cycles, and users' whereabouts. IoT creates a lot of information and data. It is simple to identify the platforms that consumers engage with and obtain comprehensive information about clients after IoB processes this previously unavailable information. These users'/customers' data can be used to develop efficient marketing strategies, after which real-time notifications and targeted advertisements can be sent to them. Businesses can utilise the comprehensive data gleaned from the IoB to enhance the broad product experience for clients. In order to gather information on individual behaviour and cognitive patterns, the IoB combines IoT, behavioural science, and data analytics. This data is analysed to learn more about behaviour used for various things, such as enhancing marketing campaigns or patient medical monitoring.
12.	Track daily activities	A health application that can keep track of a person's diet, exercise, weight, sleep patterns, heart rate, stress level, oxygen level, blood sugar levels, and similar factors can notify the user so they can seek help or advice from healthcare professionals and work towards a positive outcome using IoB. This also records information about a driver's driving habits. In order to achieve the desired goal of selling their goods and services, businesses are now leveraging the IoB to track changes in behaviour. This cutting-edge technology can help businesses in various ways, such as by improving customer interaction, detecting when customers are interested in particular products and collecting more significant insights into the user journey from discovery to purchase. Healthcare delivery will change as a result of IoB technology. More information about connected devices may be provided. Behavioural analytics give clinicians even more information to forecast chronic diseases and other health conditions and take preventative action. Predictive technologies can quickly spot trends of lifestyle behaviour or early signs of sickness by monitoring an individual's real-life behaviour through IoB.

physical movements can be monitored on a smartphone. These days many people connect our smartphones, computers, voice assistants, home and car cameras, and in the case of a smart home, practically all of the interior equipment. Our likes, dislikes, lifestyle, interests, favourite restaurants, favourite apparel stores, trip plans and locations, travel duration, purchasing habits, and much more can be revealed to a firm by this combined with the social data from our social media footprint. IoT-enabled vehicles are gaining popularity and transmitting information about drivers' driving habits [85–88]. IoT and IoB can undoubtedly deliver data-driven value that is utilised by industries. Banks can now persuade us to save more; auto insurance providers can drive safely and benefit from low premiums; health insurance providers can persuade us to lead healthy lifestyles and benefit from low premiums etc. [89,90].

In practically every business, the IoB redesigns the value chain in addition to having an impact on consumer choice. Because the IoT deals with personal data, it enters the grey legal region where it does not meet the current standard. The IoB links data to human behaviour, and decision-making companies will continuously track our activities using the massive amounts of data they previously collected from internet-connected smart products. Businesses have successfully connected all significant equipment to the internet, making it simple for them to keep on their watchlist [91–94]. IoB integrates already-existing technologies that target the individual, like facial recognition, location tracking, and big data. The goal of IoB is to record, examine, comprehend, and react to all sorts of human behaviour in a way that enables tracking and analysing those behaviours utilising developing machine learning algorithms and emerging technological advancements. The software company has created a health app for cell phones that monitors blood sugar levels, heart rate, sleep habits, and food. The software can notify the user when their health is in danger and offer behavioural suggestions for a better outcome [95–98].

8. Discussion

IoB interprets the information gathered by IoT and links it to unique human behaviours, like selecting a particular brand. IoB transforms the data and information gathered by IoT into knowledge and possibly wisdom for societal benefits. Technology, data and analytics, and behavioural science are all combined in IoB. Data is extracted using technology, and information is drawn out of the data using analytics.

Personalisation is one of the most crucial elements of any successful service. The right mix of pertinent consumers makes the business more successful. The idea behind the IoB is to transform data into insightful knowledge about various user preferences that can be used as a standard for forecasting consumer behaviour. The system determines which psychological factors affect to get a particular result. This opens up a wide range of fresh marketing strategies to attract more clients or advertise a particular product. Additionally, it makes marketing campaigns more focused, which results in more effective advertising and delighted customers.

IoB also aids in the elimination of numerous specialised studies and surveys that incur a tremendous amount of cost. Several apps can efficiently gather and analyse any information that is still available on the internet. Numerous applications already exist that evaluate user behaviour using information from gadgets and provide recommendations aimed at helping users adopt a healthier lifestyle. For a psychologist, it seems natural to classify behaviour as including things like planning, emotional experiences, interpretations, and goals. All these human occurrences are intended to be covered and "coded" by IoB. Most digital tools and apps that track our behaviour, such as while chatting, travelling, visiting locations, using services, and exercising, record the person's identity and conduct and utilise this information for various purposes.

In the case of COVID-19, the behaviour data gathered through an IoB app would enable the monitoring of a single individual's or a community's current mass activities. In order to map continuing behaviours onto the context or domain of the behaviour, this can then be complemented by pertinent context data such as geographic, organisational, process, community, medical, economic, or any other background information. The collected data is once more examined using behavioural science. IoB can affect customers' purchasing decisions, lifestyle selections, and other decisions by observing their usage patterns. The IoB improves IoT applications as IoT merely uses the data to act, whereas IoB offers a choice to customers who are most likely to take it. Healthcare professionals have several chances to manage patients utilising particular applications through IoT and IoB. IoT devices may gather metrics like heart rate, blood pressure, temperature, and more and deliver these data to software programmes, enabling remote patient monitoring. Based on the information from IoT devices, IoB can alert users to potential health issues or remind them to take their medications. People will experience efficiency, comfort, and safety in their daily lives with the help of IoB. With the aid of IoB, we can make smarter decisions. During COVID-19, this technology was employed to determine whether or not a person had worn a face mask and washed his hands. They were constantly reminded to abide by the rules to protect themselves.

9. Limitations

IoB can improve our lives significantly, but it also has significant drawbacks, with cybersecurity being the major. Cybercriminals may gain access to behavioural information about consumer buying habits or preferences and their banking information, enabling them to develop sophisticated schemes and elevate phishing to a new level. Despite the concerns mentioned above, IoB can simplify our lives by enhancing business, motivating us to lead healthier lives, or ensuring our safety in the event of pandemics. IoB has already begun to transform the customer experience industry. The difficulty of configuring access levels to users across distributed IoT networks raises concerns about data privacy and integrity. A hacker could reveal sensitive information if they obtain behaviour data. As a result, while implementing IoB-based solutions, businesses should emphasise data integrity and security the most.

On the negative side, IoB is susceptible to online dangers such as unauthorised access to private information that reveals purchasing patterns. Sensitive information, like delivery routes, property access codes, and even bank login codes, might get into the wrong hands and result in irreparable harm. Businesses must be careful and proactive within their area and adhere to stringent data safety requirements as we continue to develop stronger/stricter privacy and data usage, cybersecurity protocols, and regulations to protect us from intrusive data collecting. They must improve their current IT systems and invest in cybersecurity education and awareness campaigns to stay current. The IoB solutions may unintentionally monitor other individuals around the user, violating their privacy, when used in public spaces like schools and hospitals. People with lower incomes and limited access to technology may miss out on IoB benefits as more healthcare professionals and insurance firms incorporate wearable data into treatment plans and health coverage.

10. Future scope of IoB in healthcare

In the future, sales and shop floor employees will be monitored to gauge performance. IoB will therefore have a significant impact on raising industry productivity. In order to extract information from the data gathered by all of these devices and infer behaviours and decision-making tendencies, the IoB intends to transform it. By fusing analytics and behavioural science with data gathered from human behaviour, IoB is taking data processing to a new level. This behavioural data will be crucial in helping businesses plan and create strategies, especially for sales and marketing. It can analyse consumer data and use it for advertising products more effectively and enhancing the overall usability of a product or service, thereby achieving its primary objective of selling products. The IoB principle will become helpful for wearable technologies. Fitbits and smartwatches are examples of wearable technology that can collect data on a user's health and fitness and transmit that data in real-time to a healthcare practitioner.

For instance, corporations, yoga, and many other activities all make extensive use of technology. Any conversation regarding IoB must include a mention of IoT. An online network of physically linked things gathers and shares data and information. The IoB will become more sophisticated due to the way that devices are linked, the calculations they can do independently, and the data stored in the cloud. Businesses can use cutting-edge techniques for marketing goods and services and influencing consumer and employee behaviour by using IoB. Due to the ability to optimise consumer connections based on collected data, this technology will be beneficial to businesses.

11. Conclusion

IoB combines technologies that have been used individually for a long time: extensive data analysis, facial recognition, and location analysis. The IoB, in contrast to the IoT, which connects every component in an environment, essentially builds a global network of live beings. Platforms for customer relationship management will incorporate IoB. In healthcare, implantable and embedded IoB items can alter and repair the body's functions that have been impacted by physical trauma or disease, in contrast to wearables, which only collect data. These include automated insulin administration systems that track blood sugar levels in real-time, connected pacemakers that send data to a specific smartphone app and microelectronic retina prostheses that restore partial vision to patients with retinal disorders. Healthcare professionals may utilise customer data to assess whether people buy junk food at a much higher rate than usual. Based on this behavioural knowledge, healthcare practitioners may engage with particular people to ensure they are not endangering their health. Smart gadgets or applications may be used as health advisors to draw attention to specific health conditions. For instance, athletes may use fitness trackers or other smart equipment to assess their heart rate, daily step count, and calories. IoB products come in a variety of shapes and levels of complexity, from smartwatches and fitness trackers to implantable insulin delivery systems, ingestible sensors, and devices for brain stimulation. Better health condition diagnosis and treatment, individualised insurance

plans, more productivity, and increased public safety are just a few advantages of implementing IoB solutions at scale. IoB solutions can see suspicious activity and sound the alarm before anything happens. It will be beneficial when these start operating more independently because it will make the environment safer for everyone. The best use cases for IoB will undoubtedly be found in any company utilising IoT technology. When users depart from their ideal behaviours, they can support them by helping them make genuine lifestyle changes. The gadgets may easily adjust to the user's behaviours and help them manage their daily activities.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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