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Perception Of The Transition From The Internet Of Things To The Internet Of Humans

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Abstract: Over the past three decades, internet usage has increased dramatically. The development of a number of technologies, including social media and networking, cloud computing, block chain technology, and others, has greatly enhanced communication between people worldwide as well as between devices, resulting in the creation of strategies like the internet of things (IoT). Numerous industries, including healthcare, education, retail, finance, and many more, have begun to use these strategies more frequently. However, as the internet and related technologies developed, their primary focus was on technical features, compromising their human-centric aspects. As a result, a new idea known as the "Internet of Humans (IoH)" was created. The internet of humans has not been thoroughly studied or understood, and no precise definition has been found. This study attempts to investigate the idea of the Internet of Humans from several angles, such as cutting-edge and creative supporting technologies, human-centric considerations, and application domains. Thus, this work suggests future research topics and challenges and adds to the body of literature for comprehending the internet of humans**.**

Index Terms **– Internet of things (IoT), Internet of humans (IoH), Block chain,**

1.INTRODUCTION

The Internet of Things (IoT) has revolutionized the way devices interact, enabling smarter homes, efficient industries, and responsive urban environments. However, the rapid digitization has often sidelined the human element, leading to concerns about privacy, control, and meaningful interaction. In response, the Internet of Humans (IoH) has emerged as a progressive paradigm focusing on human values, needs, and experiences. Our current environment is entirely different from the one that existed thirty years ago, that is, prior to the European Council for Nuclear Research (CERN) opening the internet to the public. Almost every element of people's lives has been influenced by the internet. The use of the internet and the variety of services it offers have grown at an unprecedented rate during the past three decades. In just six years, the number of people using social media worldwide has increased from 2.73 billion in 2017 to 5.17 billion today, nearly tripling, and is predicted to reach 5.85 billion by 2027 [1, 2]. In just 18 years, the number of internet users worldwide has increased about fivefold, from 1.023 billion in 2005 to 5.40 billion in 2023 [3], as seen in Fig. 1. These figures demonstrate how the world is now globally connected thanks to real-time communication systems that were previously believed to be unattainable.

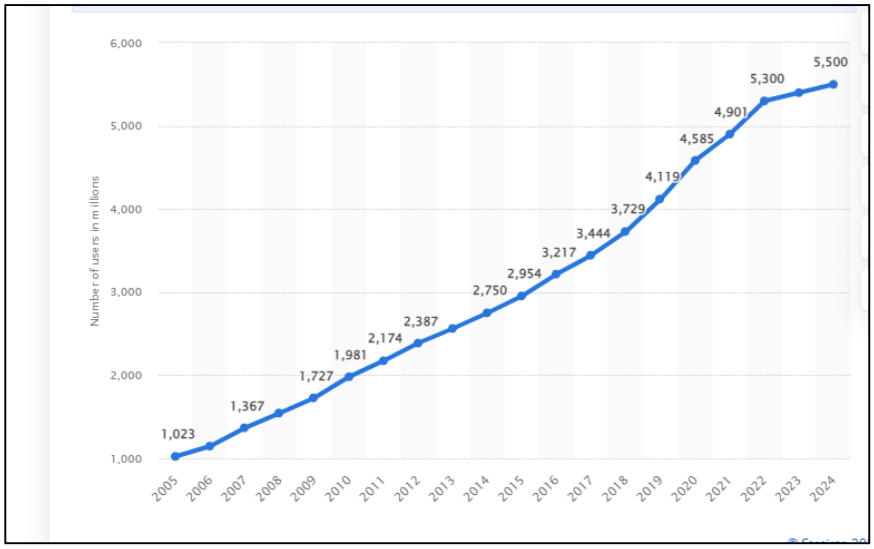

Fig.1

The internet's exponential expansion has made it a significant social, economic, technological, and political force. However, estimating the size of the internet market is difficult since its contributions must be evaluated from a variety of angles, such as empowerment, growth, and values. The internet made it possible for many economic sectors to undergo digital transformation, which resulted in the creation of creative business models that are effective and efficient in running operations and providing services. These models are gradually displacing more conventional ones in a variety of industries. The most crucial thing for people to think about, though, is how the internet has changed our society: how people live, work, interact, stay informed, make decisions, and how geographic boundaries are vanishing in the digital world as a result of reliance on the internet. Since the internet has quickly impacted people's lives in every conceivable way, its increasing significance in recent years indicates that it is no longer merely a communication tool or network. This brings up fundamental issues regarding future internet use, like whether the current internet is changing to meet people's shifting requirements. What part do businesses, individuals, and policymakers play in advancing the development of the internet? Which sectors need creative research? Should we follow a bottom-up democratic approach to decision-making to control internet use going forward, or can we leave the innovations and decision-making in the hands of a select few? Using communication technologies and the internet still causes anxiety for many people worldwide. Through a public campaign to gather and analyse public opinions on the impact of future internet technologies, the Atomium European Institute [4] conducted a study that identified a number of concerns. These concerns include privacy, cybersecurity and cybercrime, fear of job loss due to automation of services, contributing to the rise of populism, and more. 12–25% strongly disagreed, indicating a range of opinions among internet users and associated concerns about the potential effects of the internet on people in the future, whereas 24–38% strongly agreed that future Internet technologies could improve our society by increasing access, availability, cost-effectiveness, and personalisation of public services. Future internet use research [5,6,7,8] that has led to the adoption of novel models like the Internet of Things (IoT) focusses primarily on the application of the internet to objects, with little consideration given to human viewpoints like their concerns, behaviours, attitudes, etc. As a result, a novel strategy known as the Internet of Humans (IoH) has emerged. In order to improve comprehension of the significance of IoH as a futuristic strategy, this study examines and evaluates the notion of IoH and its dimensions from a variety of angles. This study's importance stems from its timely examination of IoH, a crucial but under-represented subject in the body of extant literature.

Even though the Internet of Things has received a lot of attention, there is still a clear lack of attention to the human-centric aspects of internet technologies, especially when it comes to trust, inclusion, usability, and behavioural engagement. This study's uniqueness comes from its multidisciplinary approach, which broadens the traditional definition of IoH to encompass psychological, socioeconomic, and ethical factors in addition to technological functionalities.

The key contributions of this paper include:

• A thorough explanation and conceptual model of IoH.
• An analysis of the differences between the Internet of Things (IoT), Internet of Everything (IoE), Automation of Everything (AoE), and IoH.
• The identification of human-centric elements and enabling technologies.
• Mapping the domains of practical applications.
• A research agenda that looks ahead and addresses policy, inclusion, trust, and interoperability in the adoption of IoH.

As a result, this study is a fundamental resource for scholars, professionals, and decision-makers involved in influencing the direction of human-centered internet technology. This is how the rest of the paper is structured: Section 2 presents the idea of IoH, looking at the shortcomings of IoT and the growing demand for a human-centered paradigm that is in line with social justice.
The main enabling technologies that aid in the creation and use of IoH are presented in Section 3. The fundamental human-centric aspects of IoH, such as inclusion, engagement, security, and privacy, are examined in Section 4. Potential IoH application fields across diverse businesses and social environments are examined in Section 5. In order to further the IoH paradigm, Section 6 highlights the main obstacles and suggests future fields of inquiry. Section 7 wraps up the work by providing a summary of the key conclusions and contributions.

2. UNDERSTANDING IOH

To fully realize the importance and distinctiveness of IoH, one must first comprehend the internet's basic function and the quick development of internet-based technologies in recent years. The internet has greatly impacted many facets of daily life over the last thirty years, propelling advancements like social media platforms, cloud computing, blockchain technology, and connected products. Business models, interpersonal connections, and international communication have all changed as a result of these advancements. Notwithstanding these developments, there is still a significant disconnect between the technologies created and the real-world human requirements, behaviours, and interactions that they are intended to facilitate.

This concept of technology-driven development is best shown by IoT. "The network of physical objects ('things') embedded with sensors, software, and other technologies that enable connectivity and data exchange with other devices and systems over the internet" is a typical definition of IoT [9]. Sensors, networks, actuators, and cloud intelligence are common components of IoT infrastructure, and by 2025, there will likely be more than 22 billion linked IoT devices in use [3]. Using web-based or mobile platforms, more sophisticated IoT systems use several sensors to monitor temperature, humidity, motion, and lighting. This allows for remote, intelligent control and real-time automation.

But despite IoT's potential and technological prowess, real-world implementation usually exposes human-centric flaws. Think about how many IoT sensors are integrated into contemporary cars, which are mostly used to monitor comfort, safety, and engine performance. Although these features generate initial enthusiasm, customers frequently overlook or stop using many of the functions soon after purchase because they are not well suited to human behaviour, usability, or practical requirement [8]. This phenomenon highlights a basic drawback of conventional IoT development: the failure to adequately account for human usage habits, preferences, and behavioural subtleties. Moving from a device-centric "how the world currently works" model to a human-centric "how the world should work" paradigm is necessary to address these important human-centric concern. In the creation and application of internet-connected technology, this change entails acknowledging and actively integrating human behaviours, attitudes, trust, security, privacy, and inclusivity. By changing attitudes and behaviours towards proactive self-health management, technologies like quantified-self gadgets (such as pulse checkers, stress indicators, and heart rate monitors) should empower people. But only if these technologies are specifically created with human experiences, wants, and expectations in mind will this be possible. **Internet of Humans (IoH)** refers to a network of technologies and systems that are designed to **understand, respond to, and work closely with human**

emotions, behaviors, thoughts, and needs — not just connect machines or devices.These concerns give rise to IoH, which places a strong emphasis on human-centric aspects. IoH is envisioned as a next-generation internet effort that specifically addresses fundamental human needs like inclusivity, security, and trust, according to Roberto Viola of the European Commission [10, 11]. By incorporating behavioural analytics, socioeconomic considerations, ethical norms, and psychological aspects, the current manuscript broadens the definition of IoH even more. With this enlarged definition, IoH is positioned as an ecosystem specifically created to improve human experiences, responsiveness, personalisation, and inclusivity rather than just as a technology.

IoH places more emphasis on meaningful and direct human interaction inside networked environments than IoT, which mostly involves interactions between robots and things. In addition to conventional technological fields, IoH necessitates multidisciplinary study and innovation in the fields of psychology, human–computer interface (HCI), ethics, sociology, and behavioural sciences. By comprehending and anticipating user behaviours, preferences, and ethical concerns, IoH-driven technologies proactively adapt and respond to human needs, improving user experience and trust. Furthermore, it is crucial to define and incorporate similar concepts like IoE and AoE in order to better contextualise IoH within the larger growth of linked technologies. By extending the reach of IoT beyond physical things to encompass people, processes, and data, the IoE improves value creation by fostering interconnection across many industries and domains [12, 13]. On the other hand, AoE refers to the widespread and methodical use of automation technologies, particularly Artificial Intelligence (AI) and Machine Learning (ML), which automate almost every facet of daily life, business processes, and interpersonal relationships [14]. By establishing settings where automation, connectivity, and human-centric design coexist together, IoE and AoE ideas greatly enhance and supplement IoH. This makes digital technologies more sensitive to human experiences and societal demands. The idea of the Internet of Humans (IoH) thus signifies a complete paradigm change, from a solely technological and automation-driven approach to an internet ecosystem that is inclusive, morally conscious, and behaviourally responsive. To the best of the authors' knowledge, there is still a dearth of academic literature that specifically defines IoH; the majority of definitions that are accessible concentrate only on inclusion, security, and trust, as demonstrated by Roberto Viola's seminal definition. By incorporating thorough behavioural, psychological, socioeconomic, and ethical aspects, this manuscript distinctively expands on Viola's conceptualisation and makes a substantial contribution to a more comprehensive and multidisciplinary understanding of IoH. The enabling technologies, human-centric elements, application domains, and major hurdles are further examined in the sections that follow, highlighting IoH's potential to have a significant impact on upcoming technical and societal advancements.

3. IoH Enabling Technologies

Numerous cutting-edge technologies are expanding the opportunities for internet usage in the future; some of the most important ones that potentially facilitate IoH are discussed in the sections that follow.

3.1 Artificial Intelligence (AI) and Predictive Analytics

To transform the constantly growing amount of data into knowledge and information—two essential components for granting autonomy and intelligence to networks, connected objects, and robots—innovative advancements in AI are required [15]. Furthermore, by training neural networks with methods like machine learning (ML), deep learning (DL), etc., predictive technologies can further facilitate decision-making autonomy [16]. Using the same thermostat example as previously described, its capabilities might be expanded by utilising AI technology, which can identify various elements including moisture, humidity, and power fluctuations to offer more individualised services. Moreover, ML technologies can help air conditioners function more efficiently by observing and learning user behaviour data related to AC consumption and other IoT-connected devices. Using a futuristic application, a smart house equipped with many health monitoring devices, for instance, can employ AI technology to track users' health data in real-time and machine learning techniques to determine the residents' health problems. In order to implement IoH, AI and predictive technologies can learn about human behaviour. IoH in smart homes can notify the closest recognised care provider or medical expert in the event of an emergency, addressing the missing element of how the world should function and enabling them to respond appropriately, promptly, and in accordance with human needs [10].

3.2 INTERACTIVE TECHNOLOGIES

Effective and efficient use of the IoT and IoH can result from interactive technologies that improve human-machine interactions. It has been determined that technologies like virtual reality (VR) and augmented reality (AR) are improving the human experience when utilising a variety of services across different industries [17, 18, 19]. Furthermore, IoH applications must be properly utilised by the appropriate segments of society, including individuals from various cultural backgrounds, in order to embrace the values of openness, diversity, and inclusion. In this context, applications of natural language processing (NLP) are useful for assessing the semantics of spoken languages or texts, making Internet of Things (IoH) applications usable by a variety of various groups [20, 21]. IoE and AoE are two related ideas that, in addition to IoT, greatly aid in the creation of automated and networked systems. By connecting people, processes, and data in addition to physical equipment, IoE goes beyond IoT and promotes deeper cross-sector integration [12]. In order to completely revolutionise economic models and societal interactions, the Internet of Everything (IoE) paradigm places a strong emphasis on optimising the value obtained from networked relationships [13]. AoE, on the other hand, is widespread and pervasive automation that is made possible mainly by developments in AI, ML, and autonomous systems. Its goal is to automate almost every facet of daily life, work, and human contact [14]. By establishing automated and networked environments that specifically take human behaviours, preferences, and ethical issues into account as crucial factors, IoE and AoE both greatly enhance the IoH notion and support human-centric system design principles.

3.3 BLOCKCHAIN AND METAVERSE

A blockchain is a shared, unchangeable ledger that can help with a number of tasks, including tracking down tangible and intangible assets within a network and recording transactions. Any organisation must ensure that the information it shares is accurate, given promptly, and done so in a secure manner. Blockchain technology offers instantaneous, shared, and fully transparent information recorded on an immutable ledger that is accessible only by authorised network participants, making it a potential solution to human-centric problems like privacy, security, and dependability. Blockchain technology can be useful in controlling IoH devices [22], addressing security and privacy issues, because it offers improved operating capabilities in a secure way. Using the same thermostat device in this case, a user can securely control the functions of multiple networked devices in a smart home from a distance. In a similar vein, when companies like Uber implement intelligent taxis, transportation firms, and customers without drivers in the future, blockchain technologies might be useful in managing safer transactions. As a result, it can effectively handle and manage a variety of transactions in diverse industries, and in turn, it can address IoH security challenges. In addition to blockchain, the new idea of the Metaverse plays a big role in determining the direction of the internet in the future, especially when considering it from a human-centric standpoint [23]. The extension of Digital Twins (DTs), which are virtual representations of real-world objects, into the larger social and human spheres is known as the Metaverse. In essence, it is a three-dimensional, immersive development of the conventionally linear internet that makes it possible to create realistic and interactive digital worlds that intricately combine social interactions between people, business, education, entertainment, and government.

Through the management of digital identities, the protection of digital assets, and the guarantee of transparent interactions in virtual environments, blockchain integration within the Metaverse can provide previously unheard-of security and user empowerment. By increasing user trust, encouraging inclusivity, and creating safe, fulfilling, and interesting human experiences, such integration advances the IoH vision. As an illustration of useful IoH applications, blockchain-enabled Metaverse systems might offer safe digital identities for online medical consultations, reliable educational credentials, safe online marketplaces, or engaging social environments. As a result, the capabilities of both Blockchain and the Metaverse work together to perfectly complement IoH goals, greatly enhancing user experiences, fostering trust, and fostering more dynamic and inclusive digital ecosystems.

4.IoH and Human Centric Factors

There are two ways to understand human-centric aspects. The first is how much human-centric features are taken into account while developing technology for the internet and linked devices; the second is creating the next generation of the internet of humans, which takes into account elements like engagement, inclusiveness, privacy and security, and trust. Since human factors were not taken into account when creating and developing the majority of the sensors used in cars, as previously mentioned, these factors can also be taken into consideration in this context. Key human centric factors in the context of IoH are discussed below, Fig. 3

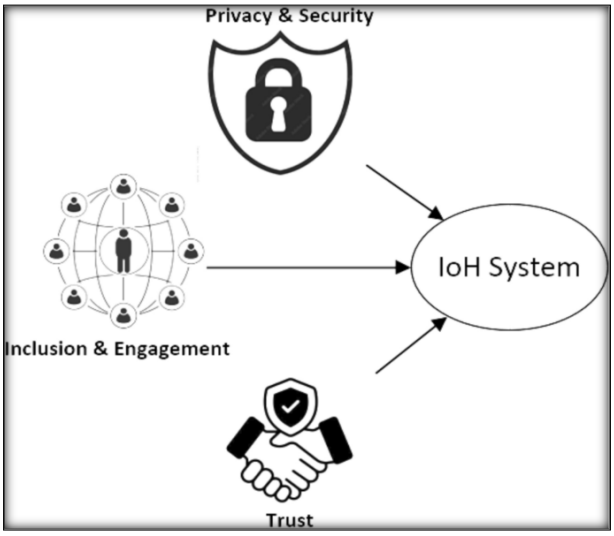

Fig.3 IoH human-centric factors

4.1 Trust

Since trust is a key factor in the development of internet technologies, it is also one of the main issues that consumers have with these technologies. Some intriguing findings from a 2020 survey of over 25,000 internet users worldwide by the Centre for International Governance and Innovation include the following: over 75% of users blamed social media companies (Facebook, Twitter, and others) for their lack of trust online, outperforming cybercriminals as the main cause. More than 53% expressed greater privacy concerns than they did a year ago, 86% fell for fake news, and 49% altered their online behaviour as a result of mistrust, such as withholding all of their personal information. These patterns demonstrate how untrusting online shoppers are. Therefore, building trust among all parties involved is crucial to the advancement of internet technologies. The factors affecting trust, however, must be viewed from a multifaceted perspective, according to research on trust-related factors involving the internet and connected devices. These factors may be related to a variety of domains, including those related to products, social influence, security, etc., and may have an impact on the adoption of internet technologies like the Internet of Things [24]. Although the acceptance of these systems is influenced by the degree of autonomy that users define, consumer mistrust may persist [25]. Therefore, in the context of IoH, trust remains a crucial human-centric aspect that may influence the adoption of internet technologies.

4.2 Privacy & Security

Without a question, the internet has accelerated globalisation by reducing barriers to international contact. Customers' privacy has been impacted by the rise in communication between strangers, whether it is when renting an IoT-enabled smart home or when exchanging personal information when making hotel reservations [26]. On the other hand, information exchange has emerged as a crucial function for enabling online transactions, without which they could not be feasible. The problem, however, is who controls the personal information, how much discretion they have in its use, and how it can impact the privacy of the customers. Even though exploiting personal data might help consumers receive better services [27], it can also be used unethically, which can have

long-term effects on individuals' socio-political decisions [28,29,30]. Customers' top concerns over the past 20 years have been privacy and security, and even with the numerous laws and regulations governing the use of personal data on online platforms, there are still a number of privacy-affecting cybercrime issues that have surfaced in recent years [31]. The European Union has taken a number of actions to address this problem, including the General Data Protection Regulation (GDPR) [32], the NIS directive [33, 34], and others. However, one of the main issues regarding future use of the internet and related technologies, particularly IoH, is the fact that many countries currently lack adequate legislation and policies.

4.3 Inclusion and Engagement

Facilitating services for customers is the internet's primary goal. It is open to everyone in society, not just a select group of powerful parties. As a result, the internet ought to address the basic requirements of people, such as those for inclusiveness, security, and trust, and it ought to generally represent the norms and values of the society. Internet of Things (IoT) systems should take social values into account and encourage equality and inclusion in society by making them accessible to everyone without excluding the elderly, persons with special needs, those in rural areas, and those with low incomes [35]. For instance, electronic health systems that require patients to fill out online forms outlining their conditions before discussing treatment plans, etc., are proving to be very challenging for those who are not tech-savvy, have limited internet access, or lack devices that can connect to the internet. It is reasonable to say that these technologies have ultimately screened out the old, those with lower levels of education, and those with any kind of visual or reading-related handicap, demonstrating that they are selective rather than inclusive. People who have access to the internet typically have better social capital results and higher levels of wellbeing [36]. In order to enable the future expansion of IoH, technologies have been evolving to include all facets of society, which may lead to increased consumer participation and engagement in IoT systems [37, 38].

5.IoH Areas of Application

There are no established applications that may be added to this section because IoH has not yet been achieved. However, given that IoH develops from IoT, a few important application areas are covered in the same context (Fig. 5). Internet technologies are becoming a significant component of every industry. Numerous strategies, including mHealth, eHealth, health information systems, and others, are being employed in the healthcare industry to enhance operational quality and efficiency as well as access to healthcare services. Furthermore, self-management practices for conditions like diabetes are utilising other communication technologies, such as Bluetooth-enabled devices, to measure blood glucose levels. A glucometer sends data to a mobile application via Bluetooth, and the application then sends the information to a healthcare server via the internet [39]. Another cutting-edge IoT example is Spire, which uses AI technology to assess physical activity and respiratory patterns and deliver real-time feedback and immediate alerts [40]. Furthermore, there are more prospects for immersive technologies in the healthcare industry and numerous other fields that can enhance how customers obtain information and services. Furthermore, the idea of an IoT-based patient-centered medical home with a variety of sensors and monitoring tools has been explored, along with the requirements and capabilities for future adoption [41]. Similar to this, the educational sector can greatly benefit from the paradigm of the internet, people, sensors, and communication technologies, particularly during the learning and experimenting processes [42]. For example, a basic tool like a scan marker that can scan text on paper and turn it into text in an application like Microsoft Word is a useful tool for taking notes while reading and underlining key points. Furthermore, the device's ability to read the text aloud to students and translate the converted text into 40 different languages shows that intelligence and interactive communication technologies are effectively integrated and focused on meeting basic human needs, such as learning. It also demonstrates how internet technologies are applied effectively for people.

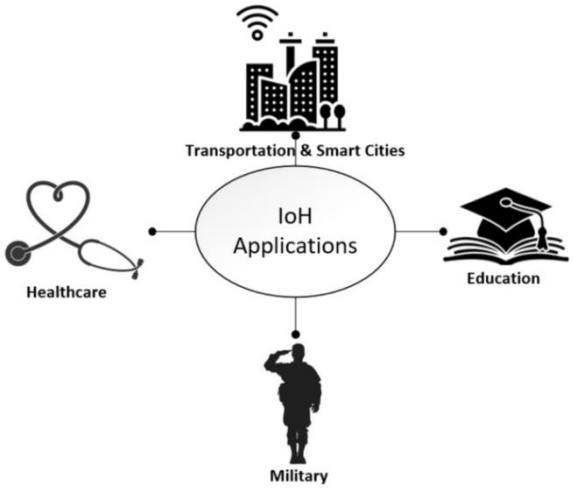

Fig.4 IoH applications

Another industry where the transition from IoT to IoH can have a greater impact is transportation and smart cities. For instance, the potential of the internet and linked devices in smart cities is shown in a fully automated transport system driven by AI and ML technologies as well as IoT techniques [43]. The impact of IoT and AI technologies on daily life is further demonstrated by the fact that robots, which will eventually outnumber humans in the city, are utilised to serve the community in a variety of functions. As a result, the internet of things is revolutionising a number of industries. However, the most crucial question is how well these systems meet the basic requirements of people, which is mostly focused on the idea of IoH. Utilising the IoH can also have an impact on military applications, primarily tracking soldiers' health, physical prowess, and well-being with the goal of improving training, enhancing physical capabilities, and empowering them to engage in combat. AR-enabled headgear, for example, can be used in combat situations. To gain control of its aircraft, military research has also made investments in neuro technology that can decipher impulses from a pilot's brain. Although these competencies may be useful in improving combat skills, they also present new security threats, such as the possibility of brain hacking or pilot mind distortion. Last but not least, IoH has the potential to influence upcoming technological trends as the technology develops, including 5G use cases like huge machine type communication and ultra-reliable low latency communication.

6. IoH Challenges and Future Research Directions

In order to improve usability, trust, and inclusion, the IoH integrates human-centric concerns into pre-existing IoT frameworks. Despite progress, there are still a number of intricate obstacles to the realisation of IoH that call for further investigation and workable answers. The sections that follow identify possible study avenues and offer thorough insights and suggestions for resolving these issues.

6.1 Interoperability and Standardization

Ensuring smooth interoperability between new IoH frameworks and current IoT devices is a fundamental challenge in IoH development [44, 45]. Systems, services, and devices created by different manufacturers sometimes employ proprietary protocols, which restricts scalability and integration. Therefore, some possible lines of inquiry in this regard are as follows:

- The creation of open-source frameworks and universal IoH communication standards to promote interoperability.
- Development of middleware programs that convert protocols between various IoT and IoH environments.
- Performing pilot implementations and case studies to verify and improve interoperability standards in practical settings.

6.2 Privacy, Security, and Trust

Building trust, guaranteeing strong security, and protecting user privacy are top priorities. Systems commonly interact with sensitive personal data due to the human-centric nature of IoH, necessitating high degrees of data governance and transparency, as noted in [31, 43]. Thus, a few possible lines of inquiry are as follows:

- Examining privacy-preserving solutions for Internet of Health applications, such as safe multiparty computation, federated learning, and differential privacy.
- Creating blockchain-based IoH data management platforms that increase user confidence by providing security and transparency.
- Performing empirical research on how users perceive privacy and trust in IoH, offering data-driven insights to inform system design.

6.3 Inclusion and Engagement

Due to a lack of accessible and inclusive design principles, many IoH applications unintentionally leave out groups like the elderly, those with impairments, or people from low-income neighbourhoods [46]. Therefore, the following additional research studies are needed:

- Applying inclusive design concepts to IoH development procedures to provide fair access irrespective of users' socioeconomic, cognitive, or physical conditions.
- Using user-centric participatory design techniques to assess current IoH services, actively involving a range of user groups in system development and assessment.
- Examining AI-powered accessibility features specifically designed for wider, more inclusive user interaction, such as voice-activated control, natural language interfaces, and adaptive user interfaces.

6.4 Policy, Regulation, and Governance

As stated in [47], the creation of logical governance frameworks and regulatory policies—which are necessary to strike a balance between innovation and ethical, legal, and societal concerns—has lagged behind the quick expansion of IoH technologies. Therefore, additional research is required in the following areas:

- Creating ethical standards and regulatory frameworks for the implementation of IoH, with an emphasis on responsibility, openness, and moral data handling.
- To guarantee comprehensive governance strategies, interdisciplinary research collaborations comprising policymakers, legal experts, technologists, and ethicists are being engaged.
- Forming cross-border regulatory partnerships to develop uniform international standards that take into account the worldwide scope of IoH technology.

6.5 Socio-Economic Impact and Adoption

Finally, it's vital to comprehend the socioeconomic elements impacting IoH adoption. Widespread adoption may be hampered by obstacles relating to cost, infrastructure, literacy, and social acceptance, as noted in the study of [48]. Thus, the following are some possible study avenues:

- To gain a deeper understanding of user requirements, adoption hurdles, and the effects of IoH technologies in various socioeconomic circumstances, socioeconomic analyses and surveys are being conducted.
- Developing scalable IoH systems with a focus on resource-constrained environments in order to prove their feasibility and efficacy.
- Examining business strategies that promote sustainable and reasonably priced IoH solutions in order to promote wider acceptance and adoption.

7 Conclusion

The development of ideas like IoT, AI, and others has been greatly aided by the internet technologies' exponential expansion and increasing complexity. However, human-centric issues have often been neglected in this fast-paced technological growth. The majority of systems in use today were created primarily from a technical and operational standpoint, frequently ignoring important human aspects like user behaviour, trust, security, privacy, and inclusion. The necessity for a new, human-centered paradigm—the Internet of Humans (IoH)—has been highlighted by these enduring difficulties.

Two complimentary viewpoints are highlighted by the IoH notion as it is examined in this research. In order to ensure that innovative technologies properly match with real human behaviours, preferences, and requirements, it first advises integrating human-centric factors directly into the

design and development phases of these systems. Second, in order to promote inclusive, safe, and reliable internet solutions, IoH calls for the proactive integration of human needs, socioeconomic considerations, and ethical standards into upcoming technology breakthroughs.

This study bridges a substantial gap in the literature by thoroughly addressing the idea of IoH, defining it precisely, outlining pertinent enabling technologies, expressing important human-centric aspects, and investigating possible application domains. The knowledge and thorough suggestions offered here provide a strong basis for further study, especially in the areas of interoperability, policy implications, inclusive technology design, standardisation, and the difficulties of IoH adoption. As a result, this study not only advances our present knowledge of IoH but also lays out a clear course for future research and application in this crucial area.

8. REFERENCES

1. Clement J. Number of global social network user (2017–2025), https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/ Accessed 19 May 2025.
2. Chaffey D. Global social media research summary, Global social media statistics research summary 2024 [May 2024] (smartinsights.com), Accessed 19 May 2025.
3. Johnson J. Number of internet users worldwide from 2005 to 2023, https://www.statista.com/statistics/273018/number-of-internet-users-worldwide/ Accessed 19 May 2025.
4. Atomium European Institute, REIsearch's Media Campaign on the next generation Internet, https://eismd.eu/reisearchs-media-campaign-on-the-next-generation-internet-report/ Accessed 19 May 2025.
5. Balasundaram A, Routray S, Prabu AV, Krishnan P, Malla PP, Maiti M. Internet of Things (IoT)-based smart healthcare system for efficient diagnostics of health parameters of patients in emergency care. IEEE Internet of Things J. 2023;10(21):18563–70.
6. Cheng Z. Research on Internet of Things human-computer interaction system based on computer artificial intelligence technology. In: 2024 IEEE 2nd international conference on control, electronics and computer technology (ICCECT), Jilin, China, 2024, pp. 1135–1139.
7. Moloudian G, et al. RF energy harvesting techniques for battery-less wireless sensing, industry 4.0, and Internet of Things: a review. IEEE Sensors J. 2024;24(5):5732–45.
8. Yu K, Yu J, Luo C. The impact of mobility on physical layer security of 5G IoT networks. IEEE/ACM Trans Netw. 2023;31(3):1042–5
9. Ahmed SF, et al. Toward a secure 5G-enabled Internet of Things: a survey on requirements, privacy, security, challenges, and opportunities. IEEE Access. 2024;12:13125–45. https://doi.org/10.1109/ACCESS.2024.
10. De Keersmaeker F, Cao Y, Ndonda GK, Sadre R. A survey of public IoT datasets for network security research. IEEE Commun Surv Tutor. 2023;25(3):1808–40.
11. Internet of Humans - How we would like the internet of the future to be | Shaping Europe's digital future (europa.eu), Accessed 19 May 2025.
12. Cisco. Internet of Everything: connecting people, process, data, and things. Cisco White Papers, Cisco Systems.
13. Miraz MH, Ali M, Excell PS, Picking R. Internet of nano-things, things and everything: future growth trends. Future Internet. 2021;13(3):68. https://doi.org/10.3390/fi13030068.

14. Rohan R, Funilkul S, Pal D, Thapliyal H. Humans in the loop: cybersecurity aspects in the consumer IoT context. IEEE Consum Electr Magaz. 2022;11(4):78–84.

15. Cheng N, et al. AI for UAV-assisted IoT applications: a comprehensive review. IEEE Internet of Things J. 2023;10(16):14438–61.

16. Abbas K, Cho Y, Nauman A, Khan PW, Khan TA, Kondepu K. Convergence of AI and MEC for autonomous IoT service provisioning and assurance in B5G. IEEE Open J Commun Soc. 2023;4:2913–29.

17. Yoo S-J, Choi S-H. "Indoor AR navigation and emergency evacuation system based on machine learning and IoT technologies. IEEE Internet of Things J. 2022;9(21):20853–68.

18. Wang C, Yu X, Xu L, Wang W. Energy-efficient task scheduling based on traffic mapping in heterogeneous mobile-edge computing: a green IoT perspective. IEEE Trans Green Commun Netw. 2023;7(2):972–82.

19. Bansal G, Rajgopal K, Chamola V, Xiong Z, Niyato D. Healthcare in metaverse: a survey on current metaverse applications in healthcare. IEEE Access. 2022;10:119914–46.

20. Baby C, Khan F, Swathi J. Home automation using IoT and a chatbot using natural language processing. In: 2017 innovations in power and advanced computing technologies (I-PACT). https://doi.org/10.1109/ipact.2017.8245185.

21. Bahja M, Safdar GA. Unlink the link between COVID-19 and 5G networks: an NLP and SNA based approach. IEEE Access. 2020;8:209127–37.

22. Ren K, et al. Interoperability in blockchain: a survey. IEEE Trans Knowl Data Eng. 2023;35(12):12750–69.

23. Wang Y, Su Z, Zhang N, Xing R. Blockchain-powered virtual societies: trust-building in the metaverse. IEEE Trans Comput Soc Syst. 2022;9(6):1972–83. https://doi.org/10.1109/TCSS.2022.3211922

24. Safdar GA, Mansour A. Security and trust issues in BYOD networks. IT Professional. 2023;25(4):45–51. https://doi.org/10.1109/MITP.2023.3293714.

25. Konsta AM, Lafuente AL, Dragoni N. A survey of trust management for Internet of Things. IEEE Access. 2023;11:122175–204.

26. Wei L, Yang Y, Wu J, Long C, Li B. Trust management for Internet of Things: a comprehensive study. IEEE Internet of Things J. 2022;9(10):7664–79.

27. Alam S, Zardari S, Noor S, Ahmed S, Mouratidis H. Trust management in social Internet of Things (SIoT): a survey. IEEE Access. 2022;10:108924–54.

28. Muzammal SM, Murugesan RK, Jhanjhi NZ. A comprehensive review on secure routing in Internet of Things: mitigation methods and trust-based approaches. IEEE Internet of Things J. 2021;8(6):4186–210.

29. Lewis C, Li N, Varadharajan V. Targeted context-based attacks on trust management systems in IoT. IEEE Internet of Things J. 2023;10(14):12186–203.

30. Liu Y, Wang J, Yan Z, Wan Z, Jäntti R. A survey on blockchain-based trust management for Internet of Things. IEEE Internet of Things J. 2023;10(7):5898–922.

31. Yang Y, Wu L, Yin G, Li L, Zhao H. A survey on security and privacy issues in Internet-of-Things. IEEE Internet Things J. 2022;9(16):14943–65. https://doi.org/10.1109/JIOT.2022.3145942.

32. General Data Protection Regulation (GDPR) – Official Legal Text (gdpr-info.eu), Accessed 19 May 2025.

33. Directive on measures for a high common level of cybersecurity across the Union (NIS2 Directive) | Shaping Europe's digital future (europa.eu), Accessed 19 May 2025.

34. Discover eIDAS | Shaping Europe's digital future (europa.eu), Accessed 19 May 2025.

35. Kuru K, Ansell D. TCitySmartF: a comprehensive systematic framework for transforming cities into smart cities. IEEE Access. 2020;8:18615–44.

36. Farooq MS, Javid R, Riaz S, Atal Z. IoT based smart greenhouse framework and control strategies for sustainable agriculture. IEEE Access. 2022;10:99394–420.

37. Albahri AS, Alwan JK, Taha ZK, Ismail SF, Hamid RA, Zaidan AA, Albahri OS, Zaidan BB, Alamoodi AH, Alsalem MA. IoT-based telemedicine for disease prevention and health promotion: State-of-the-Art. J Netw Comput Appl. 2021;173:102873.

38. Talebkhah M, Sali A, Gordan M, Hashim SJ, Rokhani FZ. Comprehensive review on development of smart cities using industry 4.0 technologies. IEEE Access. 2023;11:91981–2030.

39. Rodríguez-Rodríguez I, Zamora MÁ, Rodríguez JV. Towards a New Diabetes Mellitus Management by Means of Novel Biosensors and Information and Communication Technologies. 2017; pp. 24–29. https://doi.org/10.1145/3168776.3168795.

40. Condry MW, Quan XI. Remote patient monitoring technologies and markets. IEEE Eng Manag Rev. 2023;51(3):59–64. https://doi.org/10.1109/EMR.2023.3285688.

41. Aceto G, Persico V, Pescapé A. "Industry 4.0 and Health: Internet of Things and advanced wearable devices. J Netw Comput Appl. 2020;170: 102674. https://doi.org/10.1016/j.jnca.2020.102674.

42. Huda MQ, Maseleno A. Educational systems integration with Internet of Things. Comput Electr Eng. 2021;93: 107269. https://doi.org/10.1016/j.compeleceng.2021.107269.

43. Pournaras E. Proof of witness presence: blockchain consensus for augmented democracy in smart Cities. J Parallel Distrib Comput. 2020;145:160–75. https://doi.org/10.1016/j.jpdc.2020.07.017.

44. Xu LD, He W, Li S. Internet of Things in industries: a survey. IEEE Trans Industr Inf. 2022;18(3):1781–93. https://doi.org/10.1109/TII.2021.3102944.

45. Ray PP. A survey on Internet of Things architectures. J Netw Comput Appl. 2021;188: 103022. https://doi.org/10.1016/j.jnca.2021.103022.

46. Hussein R, Abou-Nassif GA, El Khatib SK. Exploring inclusive smart cities: a systematic review. Sustain Cities Soc. 2022;85: 104050. https://doi.org/10.1016/j.scs.2022.104050.

47. Renda A. Governing AI and IoT: between trust and regulation. Telecommun Pol. 2022;46(2): 102243. https://doi.org/10.1016/j.telpol.2021.102243.

48. Bhuiyan MN, Rahman MM, Billah MM, Saha D. Internet of Things (IoT): A review of its enabling technologies in healthcare applications, standards protocols, security, and market opportunities. IEEE Internet Things J. 2020;8(13):10474–98. https://doi.org/10.1109/JIOT.2020.3032928.