The Value-Laden Nature of Technological Infrastructures: Human Influence on Technological Development and Usage

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Abstract

Technological infrastructures are often considered neutral and devoid of inherent values or ethical considerations. However, this perception is misleading, as human values, choices, and influences deeply embed most technologies, shaping their operations and responses. The study aims to develop an understanding of how technological system development takes place with social values through case studies drawn from the health care, communication, and transportation sectors. This paper presents case studies of technological infrastructures to explore their value-laden nature, focusing on how human decisions about technology development, deployment, and use come into being. Through a review of extant literature, it investigates social, ethical, and cultural values that inform technological design and demonstrates how technologies reflect and perpetuate existing power relations, biases, and ideologies. The study concludes that understanding the influence of humans on technology will be critical to bringing equitable, inclusive infrastructural provision for more diverse services.

1.0 Introduction

The most general assumption about technological infrastructures, from the Internet to healthcare systems, is that they are value-neutral, simply existing to perform their designed functions without reflecting human biases or societal norms. However, technological systems do not emerge in a vacuum. They are the result of human decision-making shaped by various social values and other economic and political concerns (Yeung, 2019; The Consilience Project, 2022). Human choices in technology design, from the coding of algorithms to the physical structure of networks, reflect specific worldviews and cultural preferences. These deliberate or otherwise embedded values in technology mean that, as Winner (1986) argues, it is impossible to separate the ethical and social dimensions from technological design and use. The term "value embedded" or "value-laden," in this case, implies that technology is not neutral but, in fact, carries within it the values, beliefs, and priorities of those who are designing, developing, and using it. Values can come in the form of ethical concerns, social norms, and cultural expectations linked with the development, design, and functioning oftechnology.Technological infrastructures are not value-neutral. The development and diffusion of technology, along with its application and impact within society, embed human values, choices, and social priorities.

Heyndels (2023), a critical study on the value-laden nature of technology, demonstrates how human influence permeates both technological design and use. While philosophers, researchers,

and authors like Noam Chomsky and Joseph Pitt have gone so far as to defend the neutrality of technology, the claim that it is neutral is debatable (Klenk, 2021). For example, Chomsky says that while technology does not influence human decisions, humans influence its application, which makes it neutral (Miller, 2021; Klenk, 2021). One such example is when he argued that using technology is like using a hammer, which does not determine whether you use it to kill a person or build a house. However, while some may argue that technology is neutral, authors like Miller (2021) and Klenk (2021) counter the neutrality thesis by linking the application to human development and thinking. Furthermore, focusing solely on the value of technology implies a potential loss of individual responsibility for those who develop and misuse it, leading to potential legal gaps (Yeung, 2019).

Technological infrastructures are often presented as objective systems, neutral in value, and serving functional ends. However, adopting this view obscures the deep-seated human influence concerning technological design, development, and implementation. The issue lies in the failure to acknowledge how human values, economic priorities, and cultural norms shape the fundamental basis of technology. In some cases, technological systems represent and reinforce economic priorities, cultural norms, and societal biases, which perpetuate inequalities, further isolate communities, and reinforce strata. This paper critically analyzes the value-laden nature of technological infrastructures and presents a framework for how human values shape the system. It emphasizes the need for technologies to be functional and just, with ethical principles and social equity inspiring technological innovation.

The paper divides into six segments to appropriately discuss the study's focus. The first segment is the introduction to the paper. The second segment provides a concise review of ethics and technology design, followed by a deeper discussion of the role of humans and human actors. The third segment reviews the theoretical framework that stands to explain the relationship between technology and society. The fourth segment details case studies of value-laden technological infrastructures in health care, communication, and transportation. The fifth segment explores the ethical implications and human influence on technological design, providing insight into the roles of policymakers and technologists. The sixth and last segment concludes the paper, with only appropriate references following.

2.0 Ethics and Technology

This field of ethics seeks to understand the moral implications of technological systems and their use. One main focus is how technology designs promote or hinder ethical outcomes, such as justice, equality, and privacy. According to a study by James Moor (1985), technologies are neither essentially good nor bad. Due to their use and society, they merit ethical evaluation. Technological neutrality serves as the moral foundation for the notion that technologies are neither superior nor inferior, as their ethical implications stem solely from the human agent utilizing them and their intentions, whether good or bad (Wyatt, 2023). For instance, there is the assumption that a knife tool can be utilized to hurt another human being or to prepare a meal; it all depends on the user’s motive because morality is based on the person carrying the blade (Heyndels, 2023).

On the other hand, a less reductionist view does hold that technology can encode and thereby perpetuate particular values—some purposefully and some by accident. However, Wyatt (2023) asserts that specific historical, cultural, political, and economic contexts shape the development

of technologies, proving that they do not exist in a vacuum. Therefore, they care about the creators' values and society. For instance, facial recognition surveillance technologies inherently reflect and amplify biases, such as racial profiling, which may be unintentional but integral to their design. Indeed, this confirms that technology is not value-neutral because it may, quite reasonably, already have an active complicity in ethical violations, even before the end users' interaction.

Bruno Latour's Actor-Network Theory (ANT) also discusses the role of human and non-human actors, including technological artifacts, to co-construct social order (Wyatt, 2023). ANT emphasizes the interconnectedness of technology and society, arguing that infrastructures reflect and shape societal values. Smartphone use, for example, has a significant impact on human psychology and social reality. Intrinsic smartphone technology ecosystems develop this influence to facilitate their inherent possibilities (The Consilience Project, 2022). Therefore, one can always argue that technology, even if not explicitly designed to foster these values, has the potential to create new behaviors, values, and thoughts (Wyatt, 2023; The Consilience Project, 2022; Tollon, 2021). For instance, it is evident that the development of smartphones began with the principles of communication and information access, yet they've grown to play a crucial role in human existence, thereby indirectly affecting values.

For instance, new healthcare, communication, and transportation technologies embody efficiency, profit, and control values. Those priorities lead to systems that sometimes marginalize some groups or ignore access, safety, and inclusion issues. For example, EHRs and telemedicine systems, while intended to streamline healthcare delivery, inadvertently degrade the quality of care for underserved populations without access to enabling technology. They meet the demands of affluent and influential users at the expense of the less privileged in the digital and economic divides. Socioeconomic status, geographic location, race, and gender factors often influence access, exacerbating existing social inequalities by excluding those without access to technology from educational, economic, and political opportunities (Rim, 2023).

3.0 Theoretical Framework

Technological Determinism vs. Social Construction of Technology (SCOT)

Two variant theories, technological determinism and the social construction of technology, explain the relationship between technology and society. According to technological determinists, development is an independent, linear, and unavoidable process that compels change because it determines the structure of the rest of society, as discussed by Wyatt (2023) and Firrisa (2021). According to Joyce et al. (2023), this perspective posits that technological innovation triggers societal changes, necessitating societies to adjust to the technologies available at any given moment. Scholars have also speculated that technology acts as a conditioner of institutional situations, preconditioned by practices such as the pursuit of efficiency and productivity.Determinism holds that we cannot view technologies as neutral tools, as they reflect the values and interests of the society that created them.

Obermeyer et al. (2019) have demonstrated that the design of health algorithms reflects racial biases. Therefore, one might argue that the algorithm's influence on healthcare practices is inevitable and autonomous. Human actors intentionally or unintentionally embed societal biases

into these technologies, thus perpetuating inequality rather than serving as neutral agents of change (Yeung, 2019).On the other hand, scholars like Trevor Pinch and Wiebe challenge this deterministic view of technology using the SCOT theory. They view technologies as being developed or even set by social, cultural, political, and economic forces (Kwok & Koh, 2021). In this sense, societies actively construct technologies rather than allowing them to evolve independently. An example is transport infrastructure, where designs reflect societal values, either through massive investments in public transit that ensure access for all or autonomous vehicles such as the Tesla and other limited can editions that serve the narrow sections of the affluent (Karner & Niemeier, 2013).

The SCOT perspective reflects societal inequalities and power dynamics in the design and deployment of technologies. Technology being value-laden coheres more fully with SCOT, since such a view frames how social values and priorities influence technological design and implementation (Sundberg, 2019). This approach views technologies as products of human decisions or policies, symbolizing the biases, preferences, and norms of their creators (Heyndels, 2023). They are not autonomous agents of change. Introducing new technology ushers in a material, social, psychological, and cultural future. Inevitably, the early innovators, implementers, and users will not be able to control this future.

According to the Consilience Project report (2022), even the simplest form of technology, such as a plow, gets designed with goals like labor efficiency, productivity, and the need for food surpluses that engender a sense of security. It contributes to these principles by impacting tangible results, such as clearing land for farming. The Council of Europeans Report (2019) justifies this by arguing that, despite our tendency to view technologies like AI as neutral, we must acknowledge their human design. Human thinking influences every step, including the origination of ideas and proposals for development, design, modeling, data gathering and analysis, testing, implementation, operation, and evaluation (Yeung, 2019). Therefore, technology will always have a human influence on them, eliminating the possibility of neutrality.The contrasting position of technological determinism and SCOT provides the core of the argument that technological infrastructures are always value-laden and, subsequently, have ethical implications (Firrisa, 2021; Heyndels, 2023). This may suggest that technological determinism creates a situation in which the social changes that follow the development of technology are self-evident.

In contrast, the biases and inequities of the technology remain hidden. On the other hand, SCOT points to how active human actors construct technological development under social, political, and economic influences.According to a SCOT viewpoint, technologies represent power and are organizational and structural representations of society's ideals. This method demonstrates the fundamental political nature of technologies, prompting questions about the critical and ethical viability of this approach to their creation (Wyatt, 2023). For example, there is a possibility that these technologies will perpetuate social injustices. Consequently, a value-sensitive design approach should embed ethics into evolving technology infrastructures to ensure coherence with justice, privacy, and autonomy principles.

4.0 Case Studies of Value-Laden Technological Infrastructures

Technology in healthcare delivery has been widely embraced to facilitate better healthcare delivery. Technologies like electronic health record (EHR) systems and telemedicine programs

are designed and implemented to enhance efficiency and access to healthcare and services. Considering their use, it is evident that neither their creation nor implementation is technology-neutral, thinking they must be designed to meet the user experience and expectations. This implies that this technology's service delivery depends on human values. This technological design could sometimes undermine patient care and efficiency for the benefits and profit-making. For example, EHRs were intended to document processes efficiently and reduce errors but simultaneously burden many healthcare providers with intense degrees of "alert fatigue" and less face-to-face time with patients.

While telemedicine promises more access to health, it risks reproducing inequity in society in that those populations who do not have access to technology or even stable internet will be left further behind by adding to the digital divide and lowering the quality of care for those already marginalized (Chan et al., 2023). The fact that technologies are value-laden becomes evident when one looks at such unequal effects across populations. This calls for an approach in the design of health technologies where the principles of inclusiveness and equity should be considered.On the other hand, developing AI-driven diagnosis in the health space raises ethical questions. These big dataset-based technologies get biased in no time and compromise diagnostic and therapeutic decisions. Evidence shows that AI algorithms in medical imagery might be less accurate for people of specific racial or ethnic backgrounds because of poor representation within the training data (Yeung, 2019). This reflects how technologies can be used to continue systematic inequalities when notions of diversity and inclusivity have not been considered in their design. The communication technologies appear to reflect broader cultural values.

Social media and communication technologies often reflect a society's characteristic features. For example, Facebook, Twitter, and other systems like Instagram structure their systems to make money with algorithms that boost user engagement. Other sources of income in this regard involve advertising revenues. Most of these algorithms have unintended consequences, including amplifying misinformation, and hardening echo chambers. In some cases, the language models used in chatbots in some of the social media and business technologies produce toxic language, including racist and sexist statements, which question the neutrality and value of technology (Gehman et al., 2020).

Privacy, in particular, is one of those value-laden aspects of communication technologies. The digital online platform makes it possible for data relating to users to be collated, more often than not, without their knowledge. This issue raises ethical concerns about surveillance, data ownership, and consent. Platforms have recently received criticism during the Black Lives Matter and George Floyd protests (Yeung, 2019). The criticism was for controlling TikTok in distributing the visibility of hashtags and shadow-banning after posting Black Lives Matter content (Rim, 2023). Such an action results from human influence and programming that negatively influences neutrality (Rim, 2023).

Transportation technologies, such as autonomous vehicles and public transit systems, borrow heavily from society's values: safety, convenience, and environmental concern. Safety can be considered the principal value governing the design of autonomous vehicles because of the vast research and testing done to minimize accidents so that these technologies work under different conditions. Equipped with modern sensors, machine learning algorithms, and communication systems, AVs avoid human error and are among the leading causes of traffic accidents (Ji et al.,

2023). This acts as a driver for regulations and industrial standards concerning autonomous driving technologies.

Public transport systems also feature efficiency. Proper, real-time information and mobile applications can help passengers plan their trips well and reduce stopover times; hence, public transport may be a good choice over personal vehicles. With Avs, hands-free driving can enhance convenience by enabling passengers to indulge in other activities during travel. These issues have led electric and hybrid vehicles to develop and increase the use of environmentally friendly public transporters (Othman, 2022). Governments and industries focus on reducing emissions and energy consumption in transport sectors by formulating policies that encourage green technologies. It shapes the future of transportation to be safer, user-friendly, and environmentally responsible, showing how human values determine the function of technology use.

5.0 Ethical implications and human influence on technological design

The fact that technology is value-neutralhas been viewed as a myth for an extended period. Most contemporary technology bears the mark of its inventors' intentions, biases, and priorities. It reveals the intended use, potential beneficiaries, and potential negative impacts of its implementation. This is the case when considering the ethical considerations of value-laden technologies, which are technological systems that inherently possess ethical implications because of design and consequences to the users (Verbeek, 2023).

Most technological innovations claim neutrality as an instrument for efficiency and effectiveness, especially in healthcare, education, finance, and governance. Technically, they incorporate values into every stage of design and implementation. For instance, decision-making algorithms for hiring practices, law enforcement, or healthcare allocation typically present themselves as objective. These algorithms are fair and unbiased only to the extent that the technology developers have established them (Yeung, 2019). In cases where these algorithms originate in systems with structural inequity, they reproduce these biases, with possible amplification achieved (Yeung, 2019).

Predictive models of patient outcomes in health might perpetuate bias toward demographic groups, further encouraging disparities in access to care and quality of treatment. This goes against the principles of justice and the ethical intention of health delivery. While technologies and infrastructures frequently reflect and reinforce social power relations, raising serious ethical questions about domination and surveillance, most technologies, particularly those inherent in social platforms, telecommunication networks, and surveillance systems, are non-neutral in shaping human interaction and conduct (Moore, 2023).

Social media algorithms amplify sensationalist content or political extremism because it is intrinsically laden with values that continue to drive divisive behavior (Moore, 2023). One specific example could be the increased installation of certain surveillance technologies, such as face recognition systems, in communities of color compared to other communities. This sets a continuing tone for systemic racism and violates the individual's right to privacy. The emergence of such ethical challenges serves as a pointer to accountability in technology development and deployment so that their impact may serve general ethical standards on equity, transparency, and human dignity.

Another level, or dimension, with which value-laden technology manifests is the digital divide, which entails the unequal dissemination and access to technological resources along socioeconomic, geographic, and demographic status (Penn State University, n.d.). This is why digital learning tools are so important for academic success. Students from poorer backgrounds cannot reliably access the internet or up-to-date devices, furthering the inequalities. More significant and dramatic, though, unequal opportunities for access bring sharply into focus another moral concern: the need for all-inclusive technology policies that offer equal opportunities.

The human factor is an important consideration when understanding technological design and implementation. It highlights how technologies evolve and perform in a given society. Far from being autonomous or value-neutral, technologies are products of human decisions influenced by social, cultural, political, and economic forces (The Consilience Project, 2022). These forces reflect the priorities, ethics, and biases of the people responsible for creating and deploying technology. Underpinning this, however, is the fact that humans design technologies for a specific need or particular problem. In these ways, engineers, designers, and policymakers bring their perspectives, values, and assumptions in designing and making technologies (Yeung, 2019). For instance, medical devices designed in the Western world may consider the population needs in low-resource settings in Africa, thus creating inaccessibility. Simultaneously, most software and apps design their interfaces to cater to specific demographics, excluding individuals with disabilities and those unfamiliar with advanced technology (Nectoux et al., 2023).

The new landscape of technological infrastructures is value-laden, with policymakers and technologists taking leading roles. Therefore, policymakers could establish the necessary regulations and guidelines to develop and use technologies for equity, privacy, and welfare goals that prioritize the public interest (Center for American Progress, 2021). For example, the European Union General Data Protection Regulation sets strict limits. It is the responsibility of policymakers to prevent any form of observation or interference with a person's right to self-determination in data privacy. The human elements involved in policymaking underscore the regulatory frameworks and policies that reflect the priorities and ethics guiding the regulation of technologies. New technologies, ranging from artificial intelligence to video surveillance, face the trade-off between letting innovation progress on equal terms and paying due attention to privacy, equity, and safety. This, in turn, shapes the functionality and the impact that technologies will have in societies, reflecting the fact that they are inherently valuable infrastructures.

After all, technologists are made to account for the ethical implications of their designs. In this regard, engineers, designers, and developers are expected to be responsive to the possible impacts that might emanate from their technologies to minimize harm. This may include impact assessments, consultation with various stakeholders, and technology accessibility by all users. In this regard, technologists must design and develop technology in a way that responds to concepts such as responsible research, innovation, and safety by design. This ensures that the technologies being developed facilitate preventive design practices and build on the merits of anticipation, inclusion, and responsiveness (van Gelder et al., 2021). This makes it objective and would not lead to harm caused by human intentions.

Value relating to technology becomes a facilitator of development and, as such, a precious resource in changing individuals and groups through access and utilization. This value creates unequal opportunities for socioeconomic and demographic groups due to deterministic potentialities (Hallstrom, 2020). Indeed, the more well-off people or those living in better-off communities can easily access newer technologies, translating them into health, education, and employment opportunities. On the other hand, access to high-speed internet or even recent medical devices will be difficult for people in low-income or rural settings, highlighting disparities in these cases. The fact that certain individuals can only access these technology offerings underscores the value-laden bias inherent in their development, as they cater to specific individual standards.

The only way to ensure equal opportunities and benefits from these technologies is through equitable participation in their development and application (University of York, n.d.). In other words, developing inclusive ideals and perspectives will facilitate the assimilation of universal design principles, accessibility for people with disabilities, and valuable affordability to a wide range of users. Designers must pay much more attention to a wide range of user needs at the start of the design process in order to avoid embedding further existing inequalities. For example, designing digital tools for multilingual or low digital literacy users might bridge the gap for underrepresented populations (Nectoux et al., 2023). Developers and policymakers need to be conscious of the ethical consequences of their decisions. Moral considerations must guide decisions about what to develop and how to implement various technologies by not marginalizing the most vulnerable sections of society (Yeung, 2019).

6.0 Conclusion

Technological infrastructures need to be much more value-neutral. However, they are products of human decisions and human values, as well as cultural norms that define their formation, development, and use. Health, communication, and transportation technologies recursively articulate and create new inequalities in social relations and power distribution. To achieve more just and equitable infrastructures, one must develop a recognition of the value-laden nature of technology and take proactive steps to consider its ethical implications. Adopting value-sensitive design principles and fostering interdisciplinary collaboration will ensure we hold technologists and policymakers accountable, catering to the needs of all users, not just a select few.

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