RECALIBRATING TECHNOLOGY'S ROLE IN SOCIETY

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ABSTRACT

Social changes occur, inter-alia, by a complex combination of technological innovation, often independent and separate. This paper adopts the document analysis approach to decode how the dynamics between technology and society have evolved post-industrialization. Towards this, it maps the existing role of technology while identifying a few critical trends with the growing influence of technology on society, including the search for a universal innovation strategy, sustainability issues, and the ever-increasing dominance of technology hype. As the outcome, the study has highlighted seven factors that need to be taken into consideration while recalibrating the role of technology in society: standardization focus on technology role, enhanced adoption in allied sectors to facilitate horizontal growth of technology, causality conundrum, criticality of technology hype adjustment, approach to multi-dimensional sustainability, moving beyond market regulation towards strengthening technical regulation.

Keywords – Recalibration, technical regulation, standards, horizontal growth, social impact

1. INTRODUCTION

Technology has been defined in numerous ways in literature– (i) machine and their usage by human beings, (ii) organization of knowledge for meeting practical purposes, (iii) intelligent organization and material manipulation for useful purposes, (iv) organized knowledge, applied science, hardware, and know-how, (v) harmonically living with the environment, (vi) sociotechnical manufacturing systems and its use [1-2].

Modern society and technology are inseparable. Technology products and solutions have impacted almost every aspect of life positively and negatively. An increase in automation has increased productivity, and replaced monotonous and mundane activities, thereby saving time and other resources. The internet, social media, and smartphones have democratized the availability of information and knowledge, enhanced general awareness about climate change, and helped stay connected with relatives, friends, and stakeholders. Thus, the purposes of technology cover environmental control, human capability extension, practical purposes, and the production of services and goods.

On the flip side, the technology-led economic growth involving unbridled exploitation of natural resources is viewed as a significant contributor to adverse climate, posing threats to the sustainability of life on our planet.

A continuous effort goes into the development of technology and the motivation for it comes from the significant benefits it brings to the day-to-day lives of individuals, organizations, countless industries, and society. The authors in [3] argued that the creation and usage of technology are important and beneficial to an organization in four broad ways: innovation, competitive edge, productivity, and decision support (refer to Figure 1).

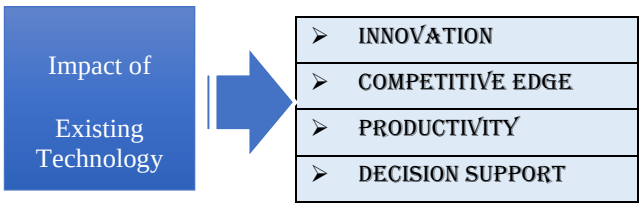

Figure 1 – Benefits of technology on organization

Innovation may lead to the creation or improvement of a method, product, or idea for solving day-to-day societal problems for ease of living. The technology acts as a tool of improvement for the company to gain a competitive edge over business rivals [3].

Technology can be viewed as net output change happening because of added efficiency and technological improvement [4]. Data analytics-based technology can generate insights about any industry and assist in making more informed and better decisions regarding time involved and quality.

In this study, we have adopted document analysis (qualitative methodology) to decode how the dynamics between technology and society have evolved post-industrialization.

2. TECHNOLOGY AND SOCIETY: A CAUSALITY SHIFT

Society may not always exploit the new possibilities from technological advancement in the immediate future [5]. Technology may be viewed as one of the necessary conditions for social change and not as a sufficient condition. Similarly, the historical perspective of technology effectively explains why a specific social tendency or propensity was realized over others at a particular time and not before.

The paper [5] also emphasized that profound social changes are affected not by one but by a complex combination of (often independent and separate) innovations that may modify user's behaviors and habits. For instance, the Industrial Revolution should be viewed as a combined complex of innovations: steam engine, coke-based iron smelting, improved transportation, and new textile machinery.

The extent of social vs commercial goods, accessibility, affordability, and adoption connected with technology may be left to market. However, for an unfair market, the above issues may not be left solely to the market forces and call for government/regulatory interventions.

Throughout human history, technology creation, changes, and their adoption by society occurred gradually with a period of lull. Regarding causality, societal needs resulted in much of the technology developments. However, in the post-industrial period, the technology evolution is taking place at a faster pace and rapid adoption by society.

The impact of technology on society is increasingly becoming more profound. Thus, of late many technologies are created first, and then efforts are made to use them for societal benefits. In other words, the changes in technology seem to be driving the changes in society. The proverb "Necessity is the mother of invention" has been weakened.

3. MAPPING THE EXISTING ROLE OF TECHNOLOGY

The Institute of Electrical and Electronics Engineers (IEEE) Society on Social Implications on Technology (SSIT) is engaged in standards development to guide complex interactions among the stakeholders linked to the development and deployment of technology in society. The SSIT focuses on five pillar areas: (i) humanitarian and global development technology, (ii) human values, ethics, and technology, (iii) future societal impact of technology advancement, (iv) technology benefits for all, (v) protecting the planet through sustainable technology [6].

3.1 Identifying the critical roles of technology

The major roles of technology can be categorized into four types: sectoral impact, social impact, economic impact, and other concerns [7], presented in Figure 2.

The impact of technology is observed more significant in six sectors: communication, information access, education, healthcare, transportation, and entertainment. The advancement in technology resulted in a foundational change in social networking, and social interaction brought up by online communities, virtual forums, social media digital platforms, collaborative forums, and connecting people with shared interests.

Technology has enhanced the growth of economics and societal welfare through job creation, better job productivity, promotion of innovation, and assistance in the creation of better products, services, and industries. Massive industrialization, energy demand, and resulting over-exploitation of natural resources have resulted in the emission of environmentally degrading greenhouse gases, reduction in forest cover, and other environmental concerns.

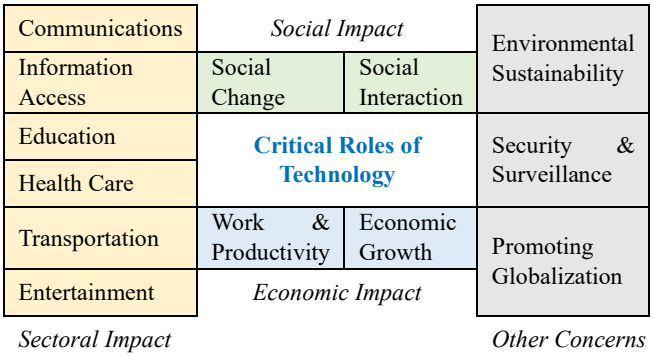

Figure 2 – Critical roles of technology

3.2 Technology and economic growth

Technological changes, including automation and artificial intelligence (AI), have been conceptualized and introduced in economic models in a variety of ways in academic studies [8] as listed below:- (i) factor augmenting – enhance effective units of the production factors, (ii) Hicks neutral – proportionate output increase for any input production factors, (iii) enhance the productivity of capital [9] capable of substituting labor, (iv) enhance labor-productivity [10]. These approaches lead to a scenario where factor-augmenting technologies exert a limited reduction in labor.

3.3 Unpredictable adoption behaviour

What role do technologies play in enabling individuals' transit out of poverty? It is important to understand the reasons why socially valuable technologies fail to timely realize their true potential [11]. For instance, information asymmetry (constraints) and divergence between the private and social value of a new technology due to externalities. The authors [11] explored the factors that impact technology adoption across space and time. The consistency between empirical estimation and underlying theoretical frameworks may be effective in optimizing the adoption behavior.

4. GROWING INFLUENCE OF TECHNOLOGY: A NEW TREND

The technological innovations and their use cases may be classified into three types. First, incremental technology relies on small innovations and changes in already existing technology, which may lead to significant improvement in products and services. Second, the semi-radical technology is similar to incremental innovation except for the difference that here the existing knowledge is improved akin to innovation. Third, disruptive technology innovation, results in the disruption of existing technology by challenging its relevance, usefulness, and value.

4.1 Futile search for a universal innovation strategy

When encountering a really hard problem, it is often advisable to expand experts in multiple related domains [12]. It is argued that every innovation strategy suffers from failure at some stage and that there is no true surest path to innovation.

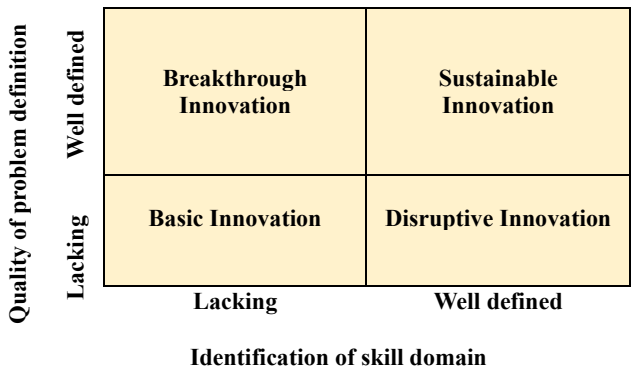

Figure 3 – Four types of innovation strategy

The secret lies in defining the problem correctly and identifying the requisite skill sets to solve it [12]. Figure 3 depicts the four possible strategies for innovation based on the quality of problem definition and identification of the skill domain: basic innovation, disruptive innovation, breakthrough innovation, and sustainable innovation.

Sustaining innovation is characterized by the best synchronization between the approach to solving the problem and the skillset required. Design thinking approach, along with framing a strategic roadmap, setting up R&D labs, and recruiting talents with matching skills and their capability upgradation are effective in this quadrant.

The cases with clarity on a problem statement but requiring exploration of unconventional skillsets domains are categorized under the breakthrough innovation quadrant. Here open innovation approach and skunk works (small sub-unit operating outside traditional or normal procedures and systems). For instance, the detection of pollution in underwater locations may need exploring teaming of a marine biologist in the team of chip designers. The scenario with a lack of clarity on understanding the problem may suit disruptive innovation (basic innovation) if the skill domain needed is clear (not clear).

Disruptive innovation is suited for scenarios where the best practices (continuous improvement in the product, changes in the marketplace, listening to customers' inputs, and bottom-line focusing) fail to deliver, indicating a shift in the basis of competition. In this scenario, the business model canvas and value proposition canvas-based innovation may work. Here, setting up innovation labs under a venture capitalist funding approach is recommended.

Basic research may lead to pathbreaking innovations (discovery of some new phenomenon) which can change the world. Setting up research divisions (which may be supported by large enterprises), academic partnerships, and publishing in journals and conferences are effective for innovations happening in this quadrant.

4.2 Sustainability issues

Schumpeter introduced the “creative destruction” concept as a new invention appears next to and eliminates the existing technology through competition [13]. Solow’s exogenous growth model emphasized that after reaching long-run equilibrium, the growth rate per capita happens and is sustainable provided some significant technical progress occurs [14]. The endogenous growth theories [15] and [16] use human capital as a central assumption. Another study by Audretsch established how Solow’s growth model links entrepreneurship capital to economic growth [17].

The study [18] examined how sustainability-conscious innovation and technology transfer can assist in achieving green growth and the effect of resulting green growth on the goal of economic growth.

4.3 Ever-increasing dominance of technology hype

A critical view considers technology hype or innovation hype as an overstated, inflated, deceptive, and erroneous prediction about its potential. On the contrary, Van Lente et al. [19] defined the technology hype of a specific technology as a promise that it holds in the future while exhibiting adequate performance capacity as it coordinates activities, collates resources, and invites competition. Looking from the perspective of stakeholders, including policymakers and regulators, the hype may present an opportunity and pitfall. Consultancy agencies often use hype cycles to influence performance expectations and strategic decisions on priority and investments.

Businesses connect innovation to profit-making and often overhype it [20]. In the words of Rita Brown, a business teacher - “*Competition drives innovation, and with our current global environment, innovation is a must for companies to survive*”.

4.4 How and why aspects of technology hype

A few companies have developed a tendency to create a problem first and then innovate to create a solution for that problem. For example, Shift Robotics developed moonwalkers that, if attached to someone's feet, can increase the pace of walking [20].

It is critically important to distinguish overhyped promises from genuine technological progress to avoid getting swayed away and becoming the victim of exaggerated expectations Technology hype and general hype follow some common patterns. Technology hype is often fuelled by a combination of visionary promises, compelling demonstrations, influential advocates, media coverage, and broader societal trends. The how elements of technology hype may be classified into 8 types: innovation and disruption; early adaptors and evangelists; demonstrations and prototypes; media and press coverage; social media and online communities; strategic partnerships and collaborators; funding and investment; regulatory and policy development. Similarly, there are eight important types of why elements of technology hype: market potential; competitive advantage; funding and investment; market adoption; economic growth; cultural impact; network effects; and psychological factors.

While hype can drive economic growth, promote innovation, and inspire social change, it can be used to critically evaluate the context and content that goes behind the building of the hype. It can successfully distinguish exaggerated claims from genuine breakthroughs.

4.5 Other concerns

There are legitimate concerns about technology's detrimental effects. Screen addiction can negatively impact mental health, especially for kids. Misinformation on social media divides public opinion. Automation may disrupt jobs and widen inequality. Surveillance threatens privacy rights. Tech addiction distracts us from living in the moment.

Overall, technology will continue shaping society in both beneficial and concerning ways. It is a double-edged sword requiring thoughtful regulation and wisdom in how we integrate it into our lives. With conscientious implementation, tech can empower people while minimizing downsides. Discernment and balance are key.

5. RECALIBRATING THE ROLE OF TECHNOLOGY IN SOCIETY: SUGGESTIVE CHANGES

The few trends identified due to the growing influence of technology on society call for exploring and recalibrating the role of technology in society. In this section, the impact of various frameworks employed to assess the impact of technology on society has been explored. Next, a few points to be taken into consideration while recalibrating the role of technology in society are discussed (refer to Figure 4).

5.1 Exploring the impact of novel assessment frameworks

The study commissioned by Brey investigates criteria to assess the ways technology impacts and contributes to the quality of life in society [21]. The author suggested an assessment framework for (i) defining criteria for the quality/goodness of society, (ii) examining how technologies and their applications promote the goodness of society in line with identified criteria, (iii) contributing to the development and application of technologies that promote goodness in society.

Advanced capitalist economies should be viewed as advanced global innovation systems created and sustained by interaction among advanced economies [22]. The United States holds the dominant position in this system for driving radical innovation.

Given the expansion in the set of tasks that can be carried out by machines, [8] introduced a task-oriented framework, wherein automation acts as a substitute for human labor in a broad range of tasks.

Downey proposed a unifying theory of innovation, competitiveness, and endogenous markups [23]. The theoretical framework performance is influenced by the incentive effect (the way firms respond to market concentration) and composition effect (market concentration) [23].

Figure 4- Recalibrating the role of technology in society

5.2 Standardization approach to technology role

Solow's mathematical model demonstrated the dependence of economic growth upon three determinants: labor increase, capital increase, and technical progress achieved [24]. The subsequent works established that R&D investments by businesses result in newer production methods and products

that continually stimulate economic growth. The authors in [24] evaluated the role of standardization and standards in technical progress. Standards are better in the dissemination of knowledge vis-à-vis patents. The creation of new knowledge through R&D may be an important factor. However, the broad dissemination of knowledge is also critical. Standards, developed through consensus, involving the participation of companies and other stakeholders, have been found quite effective in disseminating the technical know-how. For example – standards, technical guidelines and technical rules lead to an addition of 1% of GNP for period 1961-1966. Thus, there is a business benefit to standards (Bird, 1998).

Apart from a sectoral focus on technology standards, the activities of institutions like the Society on Social Implications of Technology [6] are a must as they are engaged in standards development to guide complex interactions among the stakeholders linked to the development and deployment of technology in society.

5.3 Enhanced adoption in allied sectors to facilitate horizontal growth of technology

The role of technology, particularly information and communication technology, is becoming increasingly application-oriented and lies outside the core sector into allied sectors. The need for the horizontal expansion of ICT applications in the allied sectors is also supported from the perspective of market economics and social sustainability [25]. Most opportunities and relevant societal problems to be resolved lie in other social and economic sectors. The regulator of the core sector needs to be more proactive in assessing the regulatory gaps existing in the core and allied sectors in collaboration with the sectoral regulators [25-26].

5.4 Causality conundrum

While society sources demand for technological innovation, the technology trends also lead to changes in society. A study by Jun introduced a patent analysis technique based on Bayesian regression and count data model [27]. The count data model assisted in the analysis of relevant technology keywords obtained from identified patent documents. The insights and experience of experts, reflected in prior Bayesian statistical distributions, were adopted for analysis to find sustainable technologies.

Sustainable technology development is critical for businesses to ensure their technological edge and competitiveness. Technology should not take a deterministic stance on what/when society must do. Ideally, society should cause and drive technological change, which should serve society's psychological, social, economic, political, and ethical interests.

5.5 Criticality of technology hype adjustment

The study by Funk paints a very grim picture of innovation and technology hype: mounting losses in start-ups, trends in slowing innovation, and waste of time and resources because of excessive technology hype [28].

Currently, we are undergoing a quantum hype marked by excessive capabilities and claims linked with quantum computing and its possible misuse to break present-day encryption techniques. The hype is supported by suppliers, vendors, a few researchers, and a few funding-frenzy startups. The quantum hype is also getting support from the governments of a few developed and developing countries that have already taken the lead and carry aspirations around technology sovereignty. The study by Ezratty proposed a few steps to mitigate the ill effects of the current hype around quantum technologies on various stakeholders and also suggested a responsible R&D and innovation approach [29].

A more accurate assessment of the economics behind any emerging technologies can be carried out as follows [28] –

(i) More details about existing implementations and their feedback

(ii) Cost structure and value potentials in the existing and new technologies

(iii) Trend of improvements in technology to bring down cost structure

(iv) Similar other technologies that may impact the technology economies

(v) Explore possible improvements in their economic performance

5.6 Follow a multi-dimensional sustainability approach

Economic development can be made environmentally sustainable and inclusive by making it STI (Science, Technology, and innovation) intensive [30]. This economic framework may be transformed and reoriented for expeditious achievement of the sustainable development goals (SDGs).

What role technological change may exert on climate change like environmental issues? One of the related studies used patent information-based analysis to evaluate the impact of technological change on environment-related innovations, environmental policy, and their diffusion [31]. The author calibrated the ENTICE model (endogenous technological change) to link energy-related R&D and carbon price [31].

Ferreira examined the role of technology transfer in the context of the European continent by focusing on patents related to the environment and using technology-organization environment and sustainability theoretical frameworks [32].

The rise of new technology and innovation hastens the reduction in the usefulness of the old technology, leading to

a lack of developer support and obsolescence of the old technology. Technology obsolescence, if unaddressed, may decline productivity while enhancing the cost and security vulnerabilities.

5.7 Moving beyond market regulation to strengthen technical regulation

The regulatory issues in any sector may be grouped under two sub-categories: market regulation (fair competition, customer interest, market distortion, market convergence, and tariff, etc.) and technical regulation (testing, certification on safety, security, standards, specification, quality, interoperability, patents, and privacy, etc.).

Mishra & Singh in their paper established that a framework for the assessment of regulatory gaps for advanced technology and its applications in allied sectors may be designed using the regulatory commons dynamics [25].

The sectoral changes are no longer driven by traditional market regulation but are increasingly driven by technological innovation and technical capabilities. The previous literature also prescribes the use of the regulatory governance paradigm for greater responsiveness in place of a purely regulatory approach [25].

6. DISCUSSION: IMPLEMENTING THE PROPOSED RECALIBRATED TECHNOLOGY'S ROLE FRAMEWORK

It is worthwhile to assess the practicability of the novel technology's role framework, explored in the previous sections. This section presents a few specific implementation cases, followed by a discussion on critical barriers and challenges, strategies to overcome them, ethical aspects, and stakeholder implications. Future researchers may also delve into these aspects.

6.1 Specific implementation cases

Let us first take the case of 5G technology, which stands for 5th-generation mobile telecommunications networks and services. It envisages connecting machines, devices, and objects through high-speed data connectivity, ultra-reliability low latency, and massive network capacity [31]. 5G technology experienced a higher engagement over standards development vis-à-vis 4G and prior generation technologies. However, its adoption by the allied sector is unsatisfactory and could not be mapped to killer use cases [32]. It establishes that the adoption of 5G technology in the allied sectors remains a critical challenge to overcome.

5G underwent a hype cycle and is presently passing through the trough phase of disillusionment which may be explained by the dominance of 'causality from technology to society' in the 5G technology. The importance of a multidimensional sustainability approach (radiation-related health issues, etc.) and the need to strengthen technical regulation has also been established in 5G.

Similarly, the lifecycles of blockchain technology and quantum technology can be appropriately mapped with the identified six factors of the technology's role framework.

6.2 Potential implementation challenges and strategies to overcome

The proposed technology's role framework may face numerous implementation challenges and hurdles. For instance, the technology hype adjustment, a key ask, may face the maximum difficulty since it may compromise the business interests of industry segments aiming to exploit niche deep technology areas. The arguments amplifying technology hype (linked to possible economic growth, innovation, and benefits of social change) may be used to scuttle genuine attempts to achieve technology hype adjustment.

Similarly, the regulatory gaps and jurisdiction overlaps among regulatory authorities of multiple sectors may adversely impact the efforts to strengthen technical regulations.

6.3 Ethical aspects and stakeholder implications

As technologies play increasingly prominent roles in the lives of individuals, the working of organizations, and other socio-economic aspects in human society, there is growing concern about their creation and usage in line with the ethical norms practiced in society. We contend that enhanced focus on standards, technology hype adjustment, causality direction from societal needs to technology, and multi-dimensional sustainability approach shall result in technology trajectory and its role, which is better aligned with ethical norms of the society. However, the adoption of technology in allied sectors may add to the complexities of the dynamics between technology and ethics.

The novel technology's role framework is expected to deliver substantial socio-economic benefits to industry and the general public. It may help policymakers and regulators to achieve effective and responsive regulatory governance and reduce the implementation gap. However, to start with, they may proactively contribute to the proposed recalibration exercise. Policymakers and industry, in particular, have to lead in facilitating standards development, technology hype adjustment, causality conundrum resolution, multi-dimensional sustainability, and technical regulation.

7. CONCLUSION

In today's society, the development and adoption of technology are considered to hold solutions to all socio-economic problems, in other words, a panacea for all ills [33]. However, it is important to understand their resource requirements, potentials, and lifecycles before introducing them to address complex issues. Separation of technology hype from real technology potential capabilities is critical to reducing the risk linked with strategic decisions [34]. Voiovich proposed five steps for dismantling the hype cycle

and replacing it with an 'attention dashboard': (i) replace the word hype with attention since hype is not connected with reality; (ii) stop chasing squirrels and focus on what you want; (iii) quantify attention without being anxious about hype; (iv) consider time as an independent element; (v) identify true attention drivers – do not rely on generic cycle [35].

In this study, we have analyzed the existing model on the role of technology in society by decoding its meaning; observing the causality shift happening in the dynamics between society and technology, and then mapping the existing role of technology in society on four impact pillars (sector, social, impact, and others). Next, a few critical trends depicting the growing influence of technology on society have been examined to suggest a few insights to be taken into consideration while recalibrating the role of technology in society (refer to Figure 4). The practicability of the novel technology's role framework has also been introduced, which may be explored further by the future researcher.

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