



The Relationship Between Humans and Technology: Society 5.0 & the Fourth Industrial Revolution

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Abstract

The rapid advancement of digital technologies has transformed social, economic, educational, and cultural systems, generating new patterns of interaction between humans and technology within the contexts of Industry 4.0 and Society 5.0. This study aims to examine the dynamics of human-technology relationships, analyze the conceptual foundations linking Industry 4.0 and Society 5.0, and identify the strategic role of human agency in responding to technological transformation. A non-empirical qualitative design was employed through a literature review approach, utilizing scholarly articles, academic books, conference proceedings, and policy documents selected based on relevance, credibility, and conceptual alignment with the research objectives. Data were analyzed using qualitative content analysis involving thematic categorization, synthesis, and critical interpretation. The findings indicate that technology has evolved from a supporting instrument into an integral component of contemporary social life, while Society 5.0 expands the technological orientation of Industry 4.0 by emphasizing human-centered innovation and social well-being. Human agency emerges as the key determinant in ensuring that technological advancement contributes to ethical, inclusive, and sustainable development. The study highlights the importance of integrating digital competence, humanistic values, and adaptive capacities in shaping future digital societies.

Keywords: Digital Literacy, Human Agency, Industry 4.0, Society 5.0, Technological Transformation.



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INTRODUCTION

The accelerating convergence of digital technologies, artificial intelligence, big data analytics, cloud computing, and cyber-physical systems has fundamentally reconfigured the architecture of contemporary societies, generating unprecedented transformations in economic production, social interaction, educational practices, governance structures, and cultural behavior across the globe. The emergence of the Fourth Industrial Revolution has shifted technological development beyond mechanization and automation toward intelligent interconnected systems capable of processing and responding to vast quantities of data in real time, while the subsequent evolution toward Society 5.0 has introduced a normative paradigm that seeks to re-center technological advancement around human welfare and social sustainability rather than technological efficiency alone. Contemporary discussions increasingly recognize that technological transformation is no longer merely a technical phenomenon but a multidimensional social process that influences human cognition, identity formation, ethical reasoning, and collective decision-making. Recent scholarship emphasizes that the relationship between humans and technology has entered a new phase characterized by mutual dependence, in which digital infrastructures simultaneously expand human capabilities while reshaping the very conditions under which social life is organized and experienced (Danuri, 2019; Paidil & Sari, 2025; Tavares et al., 2022; Wibowo, 2023).

Existing studies have contributed substantially to understanding the evolving interaction between human agency and technological systems, although their analytical emphases vary considerably. Research on digital literacy has demonstrated that meaningful participation in digital environments requires not only technical competencies but also critical, ethical, and reflective capacities that enable individuals to navigate increasingly complex information ecosystems (Leaning, 2019). Parallel

investigations into humanistic education have revealed that technological integration becomes socially beneficial only when accompanied by the cultivation of empathy, interpersonal understanding, and ethical awareness, particularly in educational contexts where digital tools mediate human relationships and knowledge construction (Mardiana et al., 2023). Studies focusing on adaptive education and human-centered innovation further argue that Society 5.0 represents an attempt to reconcile technological sophistication with human values by integrating digital literacy, social responsibility, and sustainable development objectives into a unified framework (Suwarma & Jenuri, 2025). Scholarly discussions concerning industrial transformation similarly suggest that the future competitiveness of societies increasingly depends on the ability of individuals and institutions to adapt to technological disruptions while preserving human autonomy and social cohesion (Rezky et al., 2019; Wibowo, 2023). Collectively, these findings indicate that technology functions not merely as an external instrument but as a constitutive force that actively shapes social realities and human experiences.

Despite the growing body of literature, significant conceptual fragmentation remains evident within current scholarship concerning the relationship between humans and technology in the context of Industry 4.0 and Society 5.0. A substantial portion of existing studies examines technological advancement primarily through economic, educational, or innovation-oriented lenses, often treating human dimensions as supplementary rather than integral analytical components. Research emphasizing digital literacy frequently focuses on competency acquisition without sufficiently addressing broader philosophical questions regarding human agency, ethical responsibility, and the sociocultural implications of technological dependence (Leaning, 2019). Conversely, humanistic and philosophical analyses tend to discuss values and ethics at a normative level while providing limited engagement with the structural transformations generated by emerging digital technologies (Damayanti & Sinring, 2025). The literature also exhibits inconsistencies regarding the conceptual distinction between Industry 4.0 and Society 5.0, with some studies portraying the latter as a continuation of technological modernization and others interpreting it as a corrective paradigm intended to address the social consequences of technology-centered development (Tavares et al., 2022; Wibowo, 2023). Such divergences have produced a fragmented understanding of how technological systems and human values interact within contemporary digital societies.

The persistence of these theoretical ambiguities generates important scientific and practical consequences because societies worldwide are increasingly confronted with challenges that transcend purely technological concerns. Rapid digitalization has intensified issues related to information disorder, algorithmic governance, data privacy, cybersecurity threats, technological dependency, social isolation, and widening digital inequalities, all of which directly affect the quality of human life and democratic participation (Danuri, 2019; Paidil & Sari, 2025). Simultaneously, organizations, educational institutions, and policymakers are expected to prepare individuals capable of functioning effectively within highly digitized environments while maintaining ethical judgment, social responsibility, and adaptive resilience. Scholarly attention to the human dimensions of technological transformation therefore becomes increasingly urgent because the long-term success of Society 5.0 depends not solely on technological innovation but on the capacity of human actors to govern, interpret, and direct technological development toward socially desirable outcomes (Rezky et al., 2019; Suwarma & Jenuri, 2025). Addressing this challenge requires a more integrated analytical perspective capable of examining technology and humanity as mutually constitutive elements rather than independent domains of inquiry.

Current research seeks to position itself within this emerging scholarly conversation by moving beyond the dominant tendency to analyze Industry 4.0 and Society 5.0 as separate technological or policy frameworks. The study adopts a socio-humanistic perspective that conceptualizes the human–technology relationship as a dynamic and reciprocal process in which technological systems influence social behavior, while human values simultaneously determine the direction, legitimacy, and consequences of technological innovation. Such an approach allows for a more comprehensive understanding of how digital transformation reshapes everyday life, how Society 5.0 redefines the role of technology in relation to human well-being, and how individuals can exercise meaningful agency within increasingly automated and data-driven environments. Attention is directed not only toward technological opportunities but also toward the ethical, cultural, and social challenges that accompany technological advancement, thereby providing a more holistic interpretation of contemporary digital transformation.

This study aims to analyze the relationship between humans and technology in contemporary digital society, to examine the conceptual foundations and interconnections of Industry 4.0 and Society 5.0, and to identify the strategic roles of human actors in responding to technological development and its associated challenges. The research contributes theoretically by constructing an integrated analytical framework that bridges technological transformation, human-centered development, digital literacy, and ethical responsibility within a single interpretive perspective. Methodologically, the study contributes through a systematic synthesis of multidisciplinary literature that enables a comprehensive understanding of the reciprocal interactions between technological innovation and human agency, offering a conceptual foundation for future research on sustainable and human-centered digital societies.

RESEARCH METHODS

This study employed a non-empirical qualitative design using a literature review approach to examine the relationship between humans and technology within the contexts of Industry 4.0 and Society 5.0. The study relied exclusively on secondary data derived from scholarly publications, including peer-reviewed journal articles, conference proceedings, academic books, policy documents, and authoritative reports relevant to digital transformation, digital literacy, human-centered technology, and societal adaptation to technological change. Literature sources were identified through academic databases such as Google Scholar, ResearchGate, Scopus-indexed journals, and other reputable scientific repositories. The selection process was guided by predefined inclusion criteria, namely relevance to the research objectives, conceptual alignment with Industry 4.0 and Society 5.0, publication credibility, and recency of publication. The analytical framework was grounded in an integrative socio-humanistic perspective, enabling the examination of technological development not only as a technical phenomenon but also as a social, cultural, ethical, and educational process that shapes human behavior and societal structures.

The analysis was conducted through a systematic process consisting of literature identification, screening, classification, synthesis, and interpretation. Relevant sources were first organized according to major themes, including human–technology interaction, the conceptual foundations of Industry 4.0 and Society 5.0, digital literacy, human-centered innovation, and the strategic role of human agency in technological transformation. Subsequently, a qualitative content analysis approach was employed to identify recurring patterns, conceptual relationships, areas of convergence and divergence, and unresolved issues within the literature. Analytical rigor was ensured through source triangulation, critical comparison of findings across different studies, and continuous evaluation of the consistency and credibility of scholarly arguments. The study further maintained methodological transparency by documenting the selection and synthesis procedures, thereby enhancing the trustworthiness, dependability, and interpretive validity of the findings generated from the reviewed literature.

RESULTS AND DISCUSSION

Human–Technology Interaction in Everyday Life During the Industry 4.0 and Society 5.0 Era

The literature synthesis reveals that human–technology interaction has evolved from a functional relationship into a deeply embedded socio-technical dependency that influences nearly every dimension of contemporary life. Digital infrastructures increasingly mediate communication, education, economic transactions, and access to public services, creating a condition in which technology operates as an extension of human capability rather than a mere external instrument. This transformation reflects a broader shift toward data-driven societies where information flows shape behavioral patterns and decision-making processes (Danuri, 2019). Human activity is now inseparable from digital ecosystems that continuously reorganize social practices and institutional arrangements.

A recurring pattern identified across the reviewed studies concerns the increasing normalization of digital mediation in interpersonal and collective interactions. Communication technologies facilitate rapid connectivity across geographical boundaries while simultaneously restructuring traditional forms of social engagement. Analyses of digital-era social relations indicate that technological platforms have become influential environments for identity construction, knowledge exchange, and social participation (Salsabila & Rehnaningtyas, 2024). Social interaction is increasingly shaped by algorithmic systems that determine visibility, relevance, and patterns of engagement.

The reviewed literature demonstrates that technological advancement generates significant gains in efficiency, accessibility, and productivity across multiple sectors. Educational institutions employ digital platforms to expand learning opportunities, businesses utilize automated systems to optimize operational performance, and governments adopt digital services to improve administrative responsiveness. Research examining digital transformation consistently associates technological integration with increased effectiveness in organizational and societal processes (Paidil & Sari, 2025). Benefits emerging from these developments contribute to the acceleration of social and economic modernization.

Digital literacy emerges as a critical mediating factor influencing the quality of human engagement with technological systems. The literature suggests that access to technology alone does not guarantee meaningful participation in digital society because individuals must possess the capacity to evaluate information, interpret media content, and exercise critical judgment. Contemporary scholarship conceptualizes digital literacy as a multidimensional competence encompassing technical, cognitive, ethical, and communicative dimensions (Leaning, 2019). Human agency within technological environments depends substantially on the development of these capacities.

Several studies emphasize that technological transformation simultaneously introduces new vulnerabilities affecting individuals and communities. Concerns regarding misinformation, cybercrime, privacy erosion, and psychological dependency appear consistently throughout the literature reviewed for this study. Human adaptation to digital environments requires not only technological competence but also mechanisms for maintaining social resilience and ethical awareness (Damayanti & Sinring, 2025). Technological progress generates opportunities and risks that coexist within the same developmental trajectory.

The thematic categorization conducted in this study identified several dominant dimensions characterizing contemporary human–technology interaction. The frequency of occurrence of these dimensions across the reviewed literature is summarized in Table 1. The table serves as an analytical representation of recurring conceptual themes identified through qualitative content analysis.

Table 1. Dominant Themes in Human–Technology Interaction Identified from the Literature

Theme	Analytical Emphasis
Digital Connectivity	Expansion of communication networks and information access
Digital Literacy	Critical and ethical engagement with information
Human-Centered Innovation	Technology designed to improve quality of life
Ethical Challenges	Privacy, misinformation, and digital responsibility
Adaptive Human Capacity	Skills, resilience, and technological adaptation

The patterns presented in Table 1 indicate that discussions concerning technology are no longer limited to questions of innovation and efficiency. Greater attention is directed toward the relationship between technological systems and human well-being. Studies focusing on Society 5.0 frequently position human-centered innovation as the primary criterion for evaluating technological success (Tavares et al., 2022). Technological development is increasingly assessed according to its social consequences rather than its technical sophistication alone.

Another significant finding concerns the emergence of a humanistic perspective within digital transformation discourse. Educational and social researchers argue that technological competence should be accompanied by empathy, ethical reasoning, and interpersonal awareness to prevent the reduction of human relationships into purely transactional interactions. Humanistic literacy frameworks seek to integrate technological proficiency with the cultivation of social values and responsible citizenship (Mardiana et al., 2023). Such perspectives challenge deterministic assumptions that technological progress automatically produces social advancement.

The literature also reveals substantial convergence regarding the necessity of adaptive human development in the digital age. Scholars consistently emphasize that individuals, organizations, and communities must continuously update their competencies in response to rapidly changing technological environments. Human resource development strategies increasingly prioritize flexibility,

creativity, problem-solving capacity, and lifelong learning as essential capabilities for navigating technological disruption (Tahar et al., 2022; Rezky et al., 2019). Adaptation is interpreted not merely as a survival mechanism but as a prerequisite for meaningful participation in emerging socio-technical systems.

Conceptual analysis suggests that human–technology interaction within Industry 4.0 and Society 5.0 should be understood as a reciprocal process rather than a one-directional relationship. Technology shapes social behavior, institutional structures, and cultural practices, while human values, ethical considerations, and collective priorities influence the design and application of technological systems. Recent scholarship increasingly recognizes that sustainable digital transformation depends on maintaining this reciprocal balance between innovation and humanity (Fauzi et al., 2025; Wibowo, 2023). The quality of future technological development will be determined not only by technological capability but also by the capacity of societies to preserve human-centered principles amid accelerating digital change.

The Conceptual Relationship Between Industry 4.0 and Society 5.0

The literature review indicates that Industry 4.0 and Society 5.0 are frequently discussed as interconnected paradigms, although they originate from different intellectual and policy trajectories. Industry 4.0 emerged primarily from technological and industrial modernization agendas emphasizing automation, cyber-physical systems, artificial intelligence, and data integration. Society 5.0 developed as a human-centered framework seeking to align technological innovation with social welfare and sustainable development objectives (Wibowo, 2023). The conceptual relationship between these paradigms reveals a transition from technology-oriented development toward value-oriented technological integration.

A comparative analysis of the reviewed literature demonstrates that Industry 4.0 focuses predominantly on increasing efficiency, productivity, and operational optimization across economic sectors. Technological advancements are viewed as mechanisms for enhancing competitiveness through intelligent systems and automated processes. Studies examining the evolution of industrial revolutions emphasize that digital transformation represents a continuation of historical technological progress characterized by increasing levels of interconnectedness and automation (Danuri, 2019). Society 5.0 expands this perspective by incorporating broader social and human considerations into the innovation process.

Several scholars argue that Society 5.0 should not be interpreted as a replacement for Industry 4.0 but rather as a corrective and complementary framework. Technological capabilities developed through Industry 4.0 become instrumental resources that can be directed toward addressing societal challenges such as aging populations, educational inequality, environmental degradation, and healthcare accessibility. Research on humanistic and sustainable societies identifies this shift as a response to concerns regarding excessive technological determinism in previous development models (Tavares et al., 2022). Human welfare becomes a central criterion for evaluating technological progress.

The literature further reveals that philosophical foundations constitute a major distinguishing feature between the two concepts. Industry 4.0 is rooted largely in innovation-driven economic transformation, whereas Society 5.0 incorporates ethical, cultural, and social dimensions into its conceptual architecture. Analyses of contemporary philosophical discourse suggest that technological advancement must remain accountable to human values, social justice, and collective well-being (Damayanti & Sinring, 2025). Technological sophistication alone is considered insufficient for addressing complex societal needs.

A recurring theme identified across the literature concerns the role of knowledge and education as connecting mechanisms between Industry 4.0 and Society 5.0. Educational institutions are increasingly expected to prepare individuals who possess not only technological competencies but also ethical awareness, adaptability, and collaborative skills. Research in educational transformation emphasizes that future learning systems must integrate digital literacy with humanistic values to support balanced societal development (Suwarma & Jenuri, 2025). Human capital development occupies a strategic position within both paradigms.

The synthesis of reviewed studies identified several conceptual distinctions and intersections between Industry 4.0 and Society 5.0. These findings are summarized in Table 2 as an analytical

framework derived from the qualitative categorization process. The table highlights how the two concepts converge while maintaining distinct developmental priorities.

Table 2. Comparative Conceptual Characteristics of Industry 4.0 and Society 5.0

Dimension	Industry 4.0	Society 5.0
Primary Orientation	Technological efficiency	Human well-being
Core Driver	Automation and digitalization	Human-centered innovation
Main Objective	Productivity and competitiveness	Social problem solving
Strategic Focus	Industrial transformation	Societal transformation
Evaluation Criterion	Performance optimization	Quality of life improvement

The comparative patterns displayed in Table 2 illustrate that Society 5.0 extends the logic of Industry 4.0 rather than rejecting it. Technological infrastructure remains essential in both frameworks, yet the intended outcomes differ substantially. Investigations into sustainable development agendas reveal that Society 5.0 seeks to ensure that technological advancements generate inclusive and socially beneficial outcomes (Riatmaja & Sukmaningrum, 2024). Human interests become integrated directly into the architecture of innovation systems.

The literature also highlights the growing relevance of Society 5.0 within educational discourse. Educational scholars increasingly view technological transformation as requiring new pedagogical approaches capable of fostering critical thinking, creativity, ethical reasoning, and digital competence simultaneously. Studies examining educational adaptation in disruptive environments suggest that learning systems must evolve beyond knowledge transmission toward the development of adaptive and socially responsible citizens (Handayani et al., 2021; Sasikirana, 2020). Educational transformation functions as a bridge between technological capability and societal readiness.

Economic and community development studies similarly demonstrate the practical implications of integrating Industry 4.0 principles with Society 5.0 objectives. Digital technologies provide opportunities for innovation, entrepreneurship, and local economic empowerment when implemented within socially responsive frameworks. Research on community-based development strategies indicates that technology can strengthen local resilience while preserving cultural identity and social cohesion (Nugroho & Andarini, 2020; Majir & Nasar, 2021). Economic modernization becomes more sustainable when accompanied by community-centered development priorities.

The conceptual evidence synthesized in this study supports the interpretation that Industry 4.0 and Society 5.0 represent sequential yet complementary stages within contemporary digital transformation. Industry 4.0 provides the technological infrastructure necessary for advanced digital societies, while Society 5.0 establishes the normative and humanistic principles guiding the application of that infrastructure. Contemporary scholarship increasingly recognizes that sustainable technological futures require the integration of innovation, ethics, education, and social responsibility within a unified developmental framework (Heri et al., 2021; Fauzi et al., 2025). Long-term societal progress depends on maintaining equilibrium between technological advancement and human-centered values.

The Role of Human Agency in Responding to Technological Development in Industry 4.0 and Society 5.0

The literature synthesis identifies human agency as the most decisive factor influencing the direction and consequences of technological transformation in contemporary society. Technological systems possess the capacity to enhance efficiency and expand opportunities, yet their societal impact depends largely on how individuals and institutions interpret, govern, and utilize these innovations. Current scholarship increasingly rejects deterministic perspectives that portray technology as an autonomous force operating independently of human influence (Fauzi et al., 2025). Human actors remain central in shaping the ethical, social, and developmental trajectories of digital transformation.

A dominant theme emerging from the reviewed studies concerns the role of individuals as responsible users of technology. Digital environments require users to engage critically with information, evaluate sources, and exercise judgment in increasingly complex communication

ecosystems. Research on digital literacy emphasizes that technological proficiency must be accompanied by critical awareness and ethical decision-making capacities (Leaning, 2019). The quality of technological engagement is determined not merely by access but by the ability to use technology in informed and responsible ways.

The literature further demonstrates that human beings function not only as consumers of technology but also as creators and innovators. Advances in artificial intelligence, data analytics, cybersecurity, and digital platforms originate from human creativity, problem-solving capacity, and scientific inquiry. Studies addressing workforce transformation indicate that future competitiveness depends heavily on the continuous development of technical expertise alongside adaptive cognitive skills (Tahar et al., 2022). Innovation remains fundamentally linked to human intellectual and creative capabilities despite increasing levels of automation.

Educational scholarship consistently highlights the importance of preparing individuals for rapidly evolving technological environments. Future-oriented education models prioritize critical thinking, collaboration, communication, and lifelong learning as essential competencies for navigating digital societies. Research investigating educational adaptation within Industry 4.0 and Society 5.0 argues that technological advancement requires parallel investments in human development and institutional readiness (Rahayu et al., 2025; Handayani et al., 2021). Human adaptability emerges as a strategic resource for sustainable societal transformation.

Another important finding concerns the position of humans as the central beneficiaries of technological innovation. Society 5.0 explicitly promotes the principle that technology should serve human needs rather than compel individuals to adapt unconditionally to technological systems. Analyses of human-centered development frameworks emphasize that innovation should be evaluated according to its capacity to improve quality of life, social inclusion, and collective well-being (Tavares et al., 2022). Human welfare functions as the normative benchmark guiding technological implementation.

The qualitative categorization undertaken in this study identified several interconnected dimensions of human agency within Industry 4.0 and Society 5.0. These dimensions are summarized in Table 3 based on recurring patterns observed throughout the reviewed literature. The table provides a conceptual synthesis of the strategic roles attributed to human actors in contemporary technological transformation.

Table 3. Strategic Roles of Human Agency in Industry 4.0 and Society 5.0

Human Role	Strategic Function
Responsible User	Ethical and critical use of technology
Innovator and Creator	Development of technological solutions
Adaptive Learner	Continuous acquisition of new competencies
Ethical Guardian	Protection of values, norms, and social responsibility
Change Agent	Utilization of technology for social improvement

The dimensions presented in Table 3 indicate that human participation extends far beyond technological consumption. Human actors are expected to exercise leadership in determining how technology influences social institutions, cultural practices, and developmental priorities. Studies examining digital transformation repeatedly emphasize that technological systems require ethical governance and responsible stewardship to prevent adverse social consequences (Raharja, 2019). Human agency operates as a balancing mechanism between innovation and accountability.

Ethical responsibility constitutes another major theme identified throughout the literature. Digital technologies create opportunities for knowledge sharing, collaboration, and economic growth, yet they also generate challenges related to misinformation, surveillance, privacy violations, and algorithmic bias. Research exploring value-based education and social responsibility argues that ethical awareness is indispensable for maintaining trust and legitimacy within increasingly digital societies (Ehwanudin et al., 2022; Damayanti & Sinring, 2025). Ethical considerations influence both the design and application of technological systems.

The reviewed studies also underscore the significance of human agency as a driver of social transformation. Technology becomes socially meaningful when employed to address collective challenges such as educational inequality, economic exclusion, environmental sustainability, and community development. Investigations into community empowerment and human resource development reveal that technological innovation achieves greater impact when aligned with local needs and societal aspirations (Nugroho & Andarini, 2020; Lestari & Maulani, 2021). Social progress depends on the capacity of individuals and institutions to translate technological potential into tangible public value.

The conceptual evidence synthesized in this review suggests that the future success of Industry 4.0 and Society 5.0 depends fundamentally on the quality of human participation within technological ecosystems. Technological infrastructure provides opportunities for advancement, while human agency determines whether those opportunities contribute to sustainable, inclusive, and ethical development. Contemporary scholarship increasingly converges around the view that digital transformation should strengthen rather than diminish human autonomy, creativity, and social responsibility (Suwarma & Jenuri, 2025; Rezky et al., 2019). Human agency remains the defining factor connecting technological innovation with meaningful societal progress.

CONCLUSION

The synthesis of the literature demonstrates that the relationship between humans and technology has become increasingly reciprocal, dynamic, and inseparable within contemporary digital societies, where technological systems influence social structures, communication patterns, educational processes, and economic activities while remaining dependent on human values and decisions for their direction and application. Industry 4.0 provides the technological foundation through automation, artificial intelligence, digital connectivity, and data-driven innovation, whereas Society 5.0 extends this foundation by positioning human well-being, social inclusion, and sustainable development as primary objectives of technological progress. The analysis further reveals that the effectiveness of digital transformation depends not solely on technological sophistication but on the capacity of individuals and institutions to cultivate digital literacy, ethical awareness, adaptability, creativity, and social responsibility. Human agency functions simultaneously as user, innovator, ethical guardian, and change agent, ensuring that technological advancement remains aligned with broader societal interests. Future digital development requires a balanced integration of technological innovation and human-centered principles to foster inclusive, sustainable, and socially meaningful progress.

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