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The Integration of Ethnoscience and Technology: A Review

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Abstract

This literature review critically examines the integration of ethnoscience and technology, highlighting this amalgamation's transformative impact on the social sciences field. Ethnoscience, with its focus on understanding the diverse ways human communities perceive and interact with their world, and ethnography, a methodology for the immersive study of cultures and social interactions, provide a robust framework for exploring human cognition, behavior, and societal constructs. The review delves into the key principles of ethnoscience, emphasizing the development and significance of ethnography in anthropological research and the methodological flexibility required to address contemporary challenges. This study further explores integrating technological innovations such as wearables, digital traces, and information and communication technology (ICT) into ethnographic studies, underscoring the opportunities and challenges presented by the digital era. The paper argues that incorporating technology expands the methodological toolkit available to researchers and enhances the depth and breadth of ethnographic insights into socio-economic, policy, and environmental factors influencing technology adoption across various sectors. Despite the methodological, socioeconomic, and infrastructural hurdles, the integration offers unprecedented opportunities for understanding complex social phenomena, contributing significantly to policy-making, community development, and technological innovation. This review underscores the necessity of evolving ethnographic practices to keep pace with technological advancements, fostering a deeper and more nuanced understanding of the intricacies of human life in the digital age.

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INTRODUCTION

Ethnoscience and ethnography represent pivotal methodologies within the social sciences, contributing significantly to our comprehension of human cognition, behavior, and

societal constructs. As defined by Oh (2020), ethnoscience delves into the diverse modalities through which human communities perceive and interact with their world, unveiling the rich tapestry of cultural understanding and behavioral norms that define societies. Meanwhile, ethnography, a methodological cornerstone elaborated by Wentzel (1991), offers a lens through which researchers can immerse themselves within communities to observe and document the intricacies of human culture and social interaction. The symbiotic relationship between ethnoscience and ethnography is underscored by their shared focus on human life's cultural and social dimensions. As Oh (2020) articulates, the ways in which individuals categorize and process information are deeply rooted in their cultural upbringing and societal conditioning. This perspective emphasizes the importance of engaging with the cultural and social contexts that frame human knowledge and behavior when conducting ethnographic research.

Highlighting the significance of social dynamics, Wentzel (1991) points to the essential role of learning and self-regulation within social competence. This focus on the interpersonal and behavioral underpinnings of social interaction further enriches our understanding of cultural contexts, stressing the necessity of examining social relationships and norms through ethnographic inquiry. Moreover, the scope of ethnographic research extends into examining the broader impacts of cultural and social phenomena, including economic, psychological, and health-related dimensions (Kałużna-Czaplińska et al., 2017; Aida et al., 2010; Beller & Wagner, 2017). These studies illuminate the far-reaching effects of social and cultural practices on individual and community well-being, offering critical insights for ethnographic exploration.

Interdisciplinary research further reveals the relevance of social and cultural considerations across various fields, including sustainability, healthcare, and social entrepreneurship (Leksono et al., 2019; Murphy et al., 2021; Fujiwara et al., 2022). Such perspectives underscore the integral role of ethnographic research in addressing complex societal challenges by incorporating a nuanced understanding of human behavior and social interactions. The study of social organization and behavior extends beyond human societies to encompass mammalian social structures and the cognitive dimensions of children's play (Prox & Farine, 2019; Mirski, 2015). These inquiries contribute valuable perspectives on social behaviors and interactions, reinforcing the importance of a comprehensive social lens in ethnographic research. Exploring social determinants of health, vulnerability, and computing behaviors (Costa et al., 2016; Kabir et al., 2016; Barvinski et al., 2019) further demonstrates the intricate web of factors influencing human experiences. These studies highlight the necessity of integrating a broad spectrum of social, cultural, and health-related considerations in ethnographic research to achieve a holistic understanding of human life.

In summation, the integration of ethnoscience and ethnography offers a profound toolkit for dissecting and appreciating the complex layers of human knowledge, behavior, and societal organization. The interplay of cultural sensitization, social norms, and interdisciplinary insights provides a comprehensive framework for investigating the

multifaceted nature of human communities. Through the meticulous application of these methodologies, researchers can uncover the underlying dynamics that shape human experiences, contributing to a deeper and more nuanced understanding of the social world.

KEY PRINCIPLES OF ETHNOSCIENCE

Development and Significance of Ethnography in Ethnoscience

Ethnography stands as a cornerstone within ethnoscience, playing a pivotal role in unraveling the intricacies of cultural phenomena and knowledge formation. As elucidated by Putra (2021), this methodological approach is instrumental in anthropology, facilitating the navigation of challenges inherent in achieving scientific comparability across cultural studies. Through ethnography, researchers embark on immersive journeys into the heart of human cultures, delving deep into how communities engage with their environment. This deep exploration not only sheds light on cultural practices but also unveils insights into the symbiotic relationship between societies and their natural surroundings. Rodrigues et al. (2022) underscore the significance of such insights in informing conservation efforts and promoting the sustainable utilization of biodiversity, thereby emphasizing the practical implications of ethnography in addressing pressing environmental concerns.

Moreover, Kratz (2010) delves into the epistemological underpinnings of ethnographic methods, highlighting their pivotal role in knowledge production within the transnational development arena. This discussion underscores the adaptability and versatility of ethnography in capturing the multifaceted dynamics of knowledge generation across diverse contexts. Indeed, as evidenced by Nolan & Pieroni (2013) and Fatková & Šlehoferová (2021), the methodological flexibility of ethnography proves indispensable in the success of ethnobiological initiatives and the implementation of structured data collection techniques in cognitive anthropology. By embracing ethnographic approaches, researchers can navigate the complexities of cultural landscapes with nuance and precision, laying the groundwork for comprehensive understanding and effective intervention strategies.

Furthermore, the integration of ethnoscience, ethnography, and survey research, as exemplified by Schoepfle et al. (1984) in their study of Navajo attitudes toward development and change, serves as a compelling testament to the efficacy of ethnographic methodologies in capturing cultural attitudes and behaviors. This interdisciplinary synergy enriches our comprehension of societal dynamics and underscores the holistic nature of ethnographic inquiry. Researchers can paint a comprehensive portrait of cultural phenomena by triangulating various methodological approaches, facilitating informed decision-making, and fostering cross-cultural dialogue. Thus, the development and significance of ethnography within ethnoscience transcend disciplinary boundaries, offering a multifaceted lens through which to explore and engage with the rich tapestry of human diversity.

Methodological Approaches and Flexibility in Ethnography

Ethnography stands as a versatile methodological tool in the social sciences, offering a rich tapestry of approaches tailored to various research settings and objectives. One such

approach, critical ethnography, as exemplified by Jm et al. (2012), delves into the intricate experiences of marginalized groups, such as immigrant and refugee women grappling with postpartum depression. By immersing themselves in the daily lives of these individuals, researchers can unveil nuanced narratives that traditional methodologies might overlook. This highlights the necessity for immersive research practices in capturing the multifaceted nature of human experiences, particularly in contexts where conventional surveys or interviews may fall short.

Moreover, the efficacy of ethnographic methods extends beyond traditional fieldwork settings. Tileaga et al. (2021) showcase the utility of short-term ethnography in engaging with Roma communities, where quick yet intensive interactions can foster trust and understanding. This approach not only breaks down barriers to participation but also emphasizes the importance of flexible engagement methods tailored to the unique dynamics of each community. In doing so, researchers can navigate cultural sensitivities and power differentials, ensuring that marginalized groups' voices are heard and respected within the research process.

Furthermore, the evolution of digital landscapes has ushered in new opportunities and challenges for ethnographic inquiry. Winter & Lavis (2019) explore the ethical dimensions of online ethnography, navigating issues of consent, privacy, and representation in digital environments. By leveraging digital platforms for participant observation, researchers can access virtual communities and social networks previously inaccessible through traditional fieldwork methods. However, this shift also demands critical reflection on the implications of digital mediation on research ethics and data validity. Thus, as highlighted by Haight et al. (2013), the adaptability of ethnography lies not only in its methodological diversity but also in its ability to evolve alongside shifting socio-cultural landscapes, thereby enriching our understanding of complex social phenomena in an ever-changing world.

Ethnomethodology's Contribution to Understanding Social Practices

Ethnomethodology stands at the forefront of social science research, delving deep into the mechanisms that govern social practices and interactions. At its core, ethnomethodology seeks to unravel how individuals produce and coordinate these practices within their social contexts. This approach has significantly advanced our understanding of social behavior, offering valuable insights that transcend disciplinary boundaries.

Tognoli et al. (2020) and Ochs & Solomon (2010) have significantly contributed to ethnomethodological literature by exploring coordination dynamics and autistic sociality, respectively. These studies delve into the underlying processes through which individuals synchronize their actions and behaviors during social interactions. By unpacking the nuances of coordination, researchers can discern the subtle cues and mechanisms that facilitate smooth social exchanges. Moreover, Vollmer (2023) and Kuhlen & Rahman (2023) extend ethnomethodology's reach by investigating coordination within specialized domains such as accounting practices and neurocognitive perspectives on language production. Such

interdisciplinary applications showcase the versatility of ethnomethodological approaches in dissecting complex social phenomena.

In addition to its theoretical insights, ethnomethodology holds practical significance, as evidenced by studies like that of Andreasson et al. (2018). Their analysis of the coordination between train traffic controllers and drivers from a distributed cognition perspective underscores the real-world applications of ethnomethodological research. By understanding the cognitive processes and collaborative strategies employed in operational settings, researchers can enhance the efficiency and safety of sociotechnical systems. This pragmatic dimension further underscores the relevance of ethnomethodology in science and technology studies, as it offers a lens through which to examine the intricate interplay between human actors and technological artifacts. Collectively, these studies underscore the profound impact of ethnomethodology on our understanding of social practices and interactions, both in theoretical and practical realms.

The development and application of ethnography and ethnomethodology within ethnoscience provide a comprehensive framework for exploring human cultures and social practices. The flexibility and depth of these methodological approaches facilitate a nuanced understanding of the complex interplay between cultural phenomena, knowledge production, and the sustainable use of biodiversity. This section underscores the enduring significance of ethnography and ethnomethodology in advancing ethnoscience research, offering insights into these approaches' methodological richness and interdisciplinary applications.

INTEGRATION OF TECHNOLOGY INTO ETHNOSCIENCE RESEARCH

Adaptation of Ethnographic Information System (IS) Studies to Technological Innovations

Integrating technological innovations, such as wearables and digital traces, into ethnographic information system (IS) studies represents a pivotal advancement in ethnoscience. Bariya et al. (2018) illuminate how wearable sweat sensors herald a new era in medical informatics, shifting medical data from centralized repositories to distributed networks that directly link individuals with healthcare providers. This transformative shift underscores the potential of wearable technologies to revolutionize health information systems by facilitating real-time monitoring and personalized care delivery. By enabling continuous data collection and analysis, wearables empower individuals to actively manage their health actively, fostering a more proactive approach to healthcare.

Similarly, Dong et al. (2020) delve into developing a Triboelectric-Human-Machine Interface (THMI), showcasing the integration of human biology with robotics through wearable devices. This innovation highlights the potential for wearables to enhance personalized healthcare and expand their utility into robotic applications. The convergence of human physiology with technological interfaces exemplifies a broader trend wherein the human body becomes an integral component of the technological ecosystem. As such, there arises a pressing need for IS studies to adapt to these emerging dynamics and comprehend the intricate relationship between humans and technology.

Kang & Exworthy (2022) delve into the empowering role of wearables in enabling users to proactively manage their health, signaling a paradigm shift in healthcare towards patient-centric models. This transition, facilitated by wearable technology, necessitates reimagining health information systems to accommodate user-generated health data and its implications for health behaviors and outcomes. As individuals increasingly engage in self-monitoring and self-care practices, IS studies must evolve to capture the multifaceted interactions between technology, individuals, and healthcare systems. This evolution requires a holistic understanding of the social, organizational, and human dimensions influenced by the integration of wearable technologies into information systems.

Building upon this foundation, Baskerville & Myers (2014) and Califf & Stumpf (2018) advocate for the indispensable role of ethnography in elucidating the social, organizational, and human dimensions affected by the integration of wearables into information systems. Their research underscores the necessity for ethnographic approaches to evolve with technological innovations, enabling a nuanced exploration of the complex interplay between technology and society. By adopting a qualitative lens, ethnographic studies can uncover the underlying dynamics shaping individuals' interactions with wearable technologies, shedding light on the cultural, ethical, and behavioral implications of their integration into everyday life.

The adaptation of ethnographic IS studies to technological innovations such as wearables represents a dynamic intersection of science, technology, and society. As wearables continue to permeate various facets of daily life, it becomes imperative for IS researchers to embrace interdisciplinary approaches that bridge the gap between technological advancements and human experiences. By incorporating ethnographic methodologies, IS studies can provide valuable insights into the nuanced impacts of wearable technologies on individuals, communities, and societal systems, thus informing the design, implementation, and evaluation of future information systems.

Role of Rapid Ethnographic Assessments in Technology-Influenced Contexts

Rapid ethnographic assessments have become increasingly indispensable in shedding light on the intricate dynamics of technology adoption and adaptation within various societal contexts. Through the lens of these assessments, researchers have been able to delve into the nuances of how communities interact with and incorporate technology into their daily lives. For instance, Krah & Kruijf (2013) offer a compelling case study on the adoption of e-payment systems in remote areas of Ghana, showcasing how ethnographic research can unveil local perceptions and practices surrounding technology use. This example underscores the pivotal role of rapid assessments in providing timely and contextually relevant insights that can directly inform the design and implementation of technology solutions tailored to specific communities.

Clowater (2022) explores augmented reality (AR) gaming in entertainment and leisure, mainly focusing on the popular game Pokémon Go. Through ethnographic inquiry, Clowater demonstrates how digital technologies like AR construct new layers of meaning within

physical spaces, reshaping social and cultural landscapes. This research underscores the transformative potential of technology in altering people's experiences and interactions with their environments, emphasizing the importance of ethnographic methods in capturing these evolving dynamics accurately.

Furthermore, Meidute-Kavaliauskiene et al. (2021) delve into the societal implications of autonomous vehicles and other Internet of Things (IoT) technologies. Their work highlights rapid technological advancements' profound impacts on urban living and healthcare systems. Researchers can keep pace with these technological changes by employing rapid ethnographic assessments, ensuring their research remains relevant and responsive to emerging societal shifts. This highlights the critical role of ethnographic approaches in providing insights beyond technology's technical aspects, encompassing its broader socio-cultural implications.

Rapid ethnographic assessments are crucial in unraveling the complex interplay between technology and society. By delving into the lived experiences and perspectives of individuals and communities, these assessments offer invaluable insights into how technology is adopted, adapted, and integrated into various contexts. Whether it's understanding the adoption of e-payment systems in remote areas, the transformative effects of AR gaming on place meanings, or the societal implications of IoT technologies, rapid ethnographic assessments serve as a vital tool for researchers and practitioners alike in navigating the ever-evolving landscape of technology and its impacts on society.

Incorporation of Digital Resources into Field Studies

Incorporating digital resources into field studies marks a pivotal shift in ethnographic research methodologies, presenting unprecedented opportunities and unique challenges. As highlighted by Alinejad (2018) and Jewitt & Mackley (2018), the omnipresence of digital media in contemporary society necessitates a corresponding evolution in ethnographic practices. Digital ethnography emerges as an indispensable tool for comprehending the intricacies of modern social practices and interactions, offering ethnographers a lens to explore the dynamic interplay between individuals and their digital environments.

However, integrating digital resources into field studies is not without complexities. Lokot (2018) and Wang & Liu (2021) delve into the intricate challenges posed by digital platforms, ranging from navigating issues of visibility and security online to effectively accessing and analyzing data from online communities. These complexities underscore the evolving landscape of fieldwork in the digital age, compelling ethnographers to devise novel strategies and ethical frameworks to navigate the intricacies of digital research responsibly.

Moreover, the methodological adaptations required for conducting ethnography in digital or virtual settings, as discussed by Azarova et al. (2020) and Zhao (2024), underscore the multifaceted nature of digitally mediated social interactions. The transition towards digital ethnography necessitates innovative approaches to every stage of the research process, from fieldwork to data analysis and beyond. Ethnographers must grapple with the complexities of navigating online spaces while upholding rigorous standards of ethical

research conduct, reflecting the profound impact of digital technologies on social life and research practices.

In essence, incorporating digital resources into field studies represents a paradigm shift in ethnographic research, demanding a reevaluation of traditional methodologies in light of contemporary technological landscapes. By embracing digital ethnography, researchers can unlock new avenues for understanding and interpreting the complexities of human behavior in an increasingly digital world. However, this transition requires a nuanced understanding of the challenges and opportunities inherent in conducting research within digital environments and a commitment to upholding the highest standards of ethical conduct throughout the research process.

In conclusion, the integration of technology into ethnoscience research necessitates significant adaptations in ethnographic methodologies and perspectives. The emergence of wearable technologies, rapid advances in digital media, and the proliferation of online platforms have transformed the landscape of ethnographic research, offering new opportunities and challenges for understanding the complex interplay between technology, society, and culture. Ethnographers must navigate these changes thoughtfully, leveraging digital tools and methodologies to capture the nuanced impacts of technological innovations on human experiences and social practices.

CHALLENGES OF INTEGRATING ETHNOSCIENCE AND TECHNOLOGY

Adaptation in Ethnographic Methods for Contemporary Phenomena

The rapid pace of technological advancement in contemporary society has brought about a profound transformation in the way researchers conduct ethnographic studies. Traditional ethnographic methods, once effective for understanding societal phenomena, are now being augmented and adapted to capture the complexities of modern life influenced by technological innovation. Stevens and Pukala (2020) provide a compelling example of this evolution by incorporating mass spectrometry into clinical diagnostics, demonstrating how traditional research approaches are evolving to address emerging challenges in healthcare. This illustrates a critical need for researchers to embrace innovative techniques to navigate the intricacies of modern phenomena.

Moreover, Molloy et al. (2017) highlight the effectiveness of multi-sited ethnography in examining nursing practices across various geographical locations. This approach signifies a methodological shift towards more flexible and comprehensive research designs that capture the dynamic nature of healthcare environments in the digital age. By adopting such adaptable methodologies, researchers can gain deeper insights into the interplay between technology, culture, and healthcare practices, enriching our understanding of contemporary healthcare systems.

The evaluation of telehealth services, as discussed by Greenhalgh et al. (2015), further emphasizes the importance of adaptive research methods in comprehensively assessing the impact of technology on health and illness. In an increasingly interconnected world, where digital interactions permeate every aspect of daily life, traditional ethnographic approaches

may fall short of capturing the nuances of technological interventions. Thus, there is a growing imperative for researchers to embrace innovative methodologies that can provide a holistic understanding of the role of technology in shaping health outcomes and healthcare delivery models.

Fehrer et al. (2018) also advocate for a systemic understanding of platform business models to navigate the interconnected and digitalized market landscape. This underscores the broader trend where ethnographic methodologies must evolve to keep pace with the rapid digitization of various industries. By integrating technological tools and approaches, researchers can uncover deeper insights into the dynamics of digital platforms and their implications for business strategies and consumer behavior. This highlights the importance of embracing diverse and technologically integrated research approaches to stay relevant in an increasingly digital world.

Furthermore, Reyes-Cruz et al. (2022) and McDougall et al. (2017) demonstrate innovative methods, such as video recordings and genetic analyses, to explore the practical use of assistive technologies and the environmental impact of human activities, respectively. These adaptations signify a shift towards more diverse and technologically integrated research approaches, enabling a deeper understanding of the implications of technological advancements on both human and ecological systems. As such, the evolution of ethnographic methods in response to technological innovation enhances the rigor and relevance of research and enables researchers to address pressing societal challenges in a rapidly changing world.

Challenges of Integrating Digital Resources into Ethnographic Research

The integration of digital resources into ethnographic research is not a mere technical adjustment but a profound methodological shift that demands innovative approaches and adaptability. In the contemporary era, where digital media saturates social practices, ethnographers must navigate complex terrains to capture the dynamics of human behavior and interactions accurately. Alinejad (2018) underlines this necessity for adaptation, stressing that understanding digital cultures is paramount for effective ethnographic inquiry. Traditional methods may fall short in comprehensively analyzing the impact of digital media on societal norms, thus necessitating nuanced approaches that blend conventional ethnographic techniques with digital literacy.

The application of ethnographic research in various fields, such as sports science, information systems, and cross-cultural studies, demonstrates ethnographic methodologies' versatility. Messiah et al. (2021) and Prytuliak et al. (2018) exemplify this adaptability by showcasing how ethnography can delve into the intricate dynamics of sports training and time-series data analysis. Similarly, Myers (1999) and Pink & Fors (2017) delve into the complexities of studying information systems and athletic training, emphasizing the need for ethnographic practices to evolve alongside technological advancements. These studies underscore that static methodologies risk obsolescence in the face of rapidly changing technological landscapes.

Moreover, Gertner et al. (2021) and Li (2020) shed light on the critical role of ethnographic methods in addressing contemporary societal challenges through implementation research and cross-cultural studies. Understanding the nuances of modern societies, marked by globalization and digital interconnectedness, requires innovative ethnographic approaches that go beyond conventional boundaries. Flexibility and adaptability emerge as central themes in these discussions, indicating that ethnographers must continuously refine their methodologies to capture the evolving nature of social and cultural phenomena in the digital age.

Integrating digital resources into ethnographic research demands a paradigm shift in methodology, necessitating flexibility and adaptability to navigate the complexities of contemporary society effectively. As digital technologies continue to shape human interactions and behaviors, ethnographers must remain vigilant in updating their approaches to ensure their research remains relevant and insightful. By embracing innovation and adapting to new methodological challenges, ethnographers can unlock deeper insights into the intricate interplay between digital media and social practices, ultimately enriching our understanding of the modern world.

Socio-Economic and Infrastructure Challenges in Information and Communication Technology (ICT) Adoption

The integration of innovative Information and Communication Technology (ICT) into ethnographic research confronts various socio-economic and infrastructural hurdles, as delineated by Dwivedi & Lal (2007) and Jones et al. (2012). These scholars delve into the digital divide concept and the specific impediments encountered by micro-enterprises in embracing ICT, emphasizing the necessity of comprehending the socio-economic determinants of technology adoption. Moreover, the discourse by Meso et al. (2005) and Mbuyisa & Leonard (2016) accentuates the pivotal role of mobile ICT in socio-economic progress, spotlighting technology's potential to address entrenched issues like poverty. Nonetheless, Hsieh et al. (2011) delve into the diverse forms of capital influencing ICT utilization among socio-economically disadvantaged populations, unearthing multifaceted barriers to digital inclusion.

Further insights provided by Park & Choi (2019) and Bvuma & Marnewick (2020) underscore the economic ramifications of digital innovation, positing that the adoption of ICT can substantially bolster national and local socio-economic development. However, capitalizing on these benefits necessitates surmounting significant obstacles, including constraints in infrastructure and the imperative for comprehensive support systems. The work of Ashraf et al. (2017) examines the community-level repercussions of ICT-led development in Bangladesh, proposing an expanded framework to grasp the socio-economic merits and challenges associated with ICT adoption. This underscores the indispensable role of ethnographic research in identifying and remedying barriers to effective technology integration across diverse contexts, accentuating the need for ethnographers to adapt their

methodologies to probe and alleviate the socio-economic and infrastructural challenges entwined with widespread ICT adoption.

Addressing socio-economic and infrastructure challenges in ICT adoption demands a multifaceted approach encompassing technological solutions, socio-economic policies, and infrastructural development initiatives. Efforts to bridge the digital divide must recognize and address the underlying socio-economic determinants that hinder technology adoption, such as income disparities, educational limitations, and access to resources. Additionally, investment in infrastructure, including broadband networks and digital literacy programs, is essential to ensure equitable access to ICT resources and opportunities for all segments of society. Moreover, fostering a supportive ecosystem that provides training, technical assistance, and financial incentives to individuals and businesses can facilitate the uptake of ICT and maximize its socio-economic benefits.

Furthermore, collaboration among governments, academia, and the private sector is crucial to address the complex socio-economic and infrastructural challenges hindering ICT adoption. Public-private partnerships can leverage resources and expertise from multiple stakeholders to develop innovative solutions tailored to local contexts and needs. Additionally, policies that promote competition, innovation, and investment in ICT infrastructure can create an enabling environment for the widespread adoption and use of ICT. By addressing socio-economic and infrastructure challenges comprehensively and collaboratively, societies can harness the full potential of ICT to drive inclusive socio-economic development, empower marginalized communities, and achieve sustainable growth.

POTENTIAL BENEFITS OF INTEGRATING ETHNOSCIENCE AND TECHNOLOGY

Enhancing Understanding of Socio-Economic and Policy Factors through Technology

Technology has become indispensable in unraveling the intricate web of socio-economic and policy factors that shape our communities. Leveraging technology-enhanced rapid ethnographic assessments, researchers have delved into various facets of human society, from environmental sustainability to educational dynamics and healthcare interventions. These studies shed light on the multifaceted nature of our world, highlighting the interconnectedness of demographic trends, income disparities, social structures, technological advancements, and governmental policies.

The work of Liu et al. (2020) stands as a prime example of how technology can elucidate the complexities of environmental policy impacts. Through rapid ethnographic assessments, they dissect the factors influencing household CO_2 emissions, revealing the direct effects of policies and the indirect influences of socio-economic and natural determinants. This holistic understanding is crucial for crafting effective environmental policies addressing the root causes and the broader contextual factors driving carbon emissions. Similarly, Kumar & Daniel (2016) delve into the realm of education, employing technology-enhanced methods to explore the adoption of learning technologies in Fijian polytechnic institutions. Their findings underscore the intricate interplay between socioeconomic backgrounds and educational

opportunities, highlighting how technological interventions must be tailored to the specific socio-cultural contexts to ensure equitable access and meaningful integration.

In Santiago, Chile, Walters et al. (2018) unravel the complexities of household solar PV adoption, revealing the pivotal role of policy frameworks and technological advancements in shaping environmental sustainability decisions. By employing rapid ethnographic assessments, they navigate the myriad factors influencing adoption behaviors, from governmental incentives to technological affordability, providing invaluable insights for policymakers and stakeholders seeking to promote renewable energy solutions.

Meinert et al. (2018) extend the application of technology-enhanced ethnographic methods to healthcare, where the stakes are particularly high. Their analysis underscores the delicate balance between technological innovation, security concerns, and socio-economic considerations within a value-based healthcare system. By dissecting the factors influencing technology adoption in healthcare, they offer a roadmap for policymakers and practitioners to navigate the complexities of telehealth services, ensuring that technological interventions are not only effective but also equitable and sustainable.

The studies collectively highlight the transformative power of technology-enhanced rapid ethnographic assessments in enhancing our understanding of socio-economic and policy factors. By unraveling the intricate tapestry of human society, these methods pave the way for more informed policy-making, targeted interventions, and sustainable solutions that address the underlying drivers of societal challenges. As we continue to harness the potential of technology in research and policy, we stand poised to create a more equitable, resilient, and thriving world for all.

Practical Opportunities in Ethnographic Research through Digital Integration

Integrating digital resources into ethnographic studies represents a significant advancement in research methodologies, offering many practical opportunities to enrich the investigative process. Traditionally, ethnography has relied on in-person observation and interaction, limiting the scope of data collection to physical spaces and human interactions within those spaces. However, the advent of digital technologies has revolutionized this approach, allowing researchers to access and analyze online spaces and expanding the horizons of ethnographic inquiry. As advocated by Hallett & Barber (2013), the inclusion of online space data in ethnography opens up new avenues for understanding contemporary social dynamics, reflecting the evolving nature of human interaction in the cyber era.

Moreover, the interdisciplinary potential of integrating digital resources into qualitative studies is highlighted by Crabtree et al. (2006), who emphasize the benefits of incorporating digital tools in the investigation of ubiquitous computing. By leveraging digital technologies, researchers can capture the nuances of technology use in everyday life, shedding light on how individuals interact with and adapt to technological advancements. This interdisciplinary approach enhances the depth of ethnographic analysis and fosters collaboration across diverse fields, contributing to a more holistic understanding of human behavior in technologically mediated environments.

Akemu & Abdelnour's (2018) exploration of the malleability of digital artifacts in organizational settings further illustrates the dynamic nature of digitally mediated processes and the opportunities they present for real-time study. By studying the interactions between individuals and digital tools within organizational contexts, researchers can gain insights into the complexities of modern work environments and the role of technology in shaping organizational dynamics. This real-time approach to ethnographic research enables researchers to observe and analyze phenomena as they unfold, providing valuable insights into the intricacies of human behavior and organizational practices.

Additionally, studies such as Ferreira et al. (2016)'s investigation into older people's engagement with digital video production highlight digital technology's empowering and participatory aspects in ethnographic research. By involving participants in creating digital content, researchers can gather data and empower individuals to share their experiences and perspectives in their own words. This participatory approach fosters a deeper sense of engagement and collaboration between researchers and participants, enriching the research process and enhancing the validity of findings.

ICT's Role in Facilitating Research Evaluation, Adaptation, and Uptake

ICT stands as a cornerstone in the contemporary landscape of research evaluation, adaptation, and uptake, particularly within the realm of ethnographic studies. Scholars such as Greenhalgh & Swinglehurst (2011) advocate for an ethnographic lens to understand the intricate social dynamics surrounding technology use, thereby transcending the narrow confines of positivistic evaluations. Tripathi et al. (2020) further underscore the transformative potential of ICT, exemplified in its ability to bridge healthcare delivery gaps for marginalized tribal communities. Through such examples, the significance of ICT in fostering knowledge creation and dissemination becomes evident, illustrating its pivotal role in reshaping research methodologies and outcomes.

Taylor et al. (2021) delve into the nuanced effects of ICT innovations on organizational communication, shedding light on the multifaceted nature of technological impact. Their work underscores the need for sophisticated research methodologies to capture the intricate interplay between technology and organizational dynamics. Similarly, Zewge & Dittrich (2017) delve into the developmental implications of ICT, particularly in agriculture within developing nations. Their exploration underscores the cross-cultural and developmental dimensions inherent in the adoption of technology, highlighting the need for contextualized approaches to technological integration.

In tandem, studies by Sanches & Brown (2018) and Sattarov & Nagel (2019) delve into the transformative potential of mobile ICT tools, elucidating their capacity to revolutionize data production practices and influence social identities, respectively. These investigations underscore the profound impact of ICT in expanding the horizons of ethnographic research, from refining data collection methodologies to fostering social inclusion and community engagement. Through such endeavors, ICT emerges as a facilitator and a catalyst for transformative change, amplifying ethnographic inquiries' scope and societal relevance.

The integration of ICT into ethnographic research broadens the methodological repertoire available to scholars and significantly enhances the societal impact of their findings. By harnessing the power of ICT, ethnographers can ensure the timeliness, relevance, and accessibility of their insights, thereby contributing to more informed policy-making, community development, and technological innovation. Thus, ICT serves as a tool for research facilitation and a conduit for societal progress, embodying the potential to effectuate meaningful change across diverse domains and communities.

CONCLUSION

As explored in this review, the integration of ethnoscience and technology underscores a transformative journey toward understanding and documenting human cultures, behaviors, and societal dynamics in the digital age. This synthesis of traditional ethnographic methodologies with cutting-edge technological innovations broadens the scope of ethnographic research and enhances its depth and accuracy. The adaptation of ethnographic methods to incorporate technological advances, such as wearables, digital traces, and ICT, reflects a necessary evolution to address the complexities of contemporary society.

Through ethnoscience, researchers have gained invaluable insights into the socio-economic, policy, and environmental factors influencing technology adoption across various sectors, including healthcare, education, and environmental sustainability. These insights have been pivotal in shaping policies, interventions, and innovations sensitive to diverse communities' cultural and social nuances. Furthermore, the practical opportunities afforded by the integration of digital resources into ethnographic studies have enriched research processes, enabling researchers to explore new dimensions of human interaction and organizational dynamics in unprecedented detail.

However, this integration is not without its challenges. Ethnographers face methodological, socio-economic, and infrastructure hurdles in adopting innovative ICT in their research. Despite these challenges, the potential benefits of integrating technology into ethnographic research are immense. ICT's role in facilitating the evaluation, adaptation, and uptake of research output promises to enhance the impact and reach of ethnographic findings, contributing significantly to our understanding of complex social phenomena and informing the development of more effective, culturally attuned technological solutions.

In conclusion, the marriage of ethnoscience and technology heralds a new era of ethnographic research, one that is equipped to navigate the intricacies of the digital age. As this review has demonstrated, the thoughtful integration of technology into ethnoscience research holds the key to unlocking deeper, more nuanced understandings of the human condition. Researchers must continue exploring innovative methodologies, fostering interdisciplinary collaborations, and leveraging technological advances to enrich the tapestry of human knowledge. Integrating ethnoscience and technology is far from complete, but the path forward is bright with the promise of discovery, understanding, and innovation.

LIMITATION

The integration of ethnoscience and technology, while transformative, faces several limitations including methodological constraints, ethical concerns, socio-economic barriers, infrastructure challenges, and data overload. Traditional ethnographic methods struggle to keep pace with rapid technological changes, necessitating new frameworks that are often complex to develop. Ethical issues around privacy, consent, and data security are heightened with digital tools. The digital divide and lack of reliable infrastructure in many regions hinder access to necessary technologies, potentially skewing research inclusivity. Additionally, the vast amounts of data generated by technologies like wearables pose significant management and analytical challenges, requiring advanced skills and tools not always available to researchers.

RECOMMENDATION

To overcome these limitations, it is essential to develop robust methodological frameworks that integrate digital tools with traditional ethnographic methods and establish clear ethical guidelines addressing privacy, consent, and data security. Efforts should focus on bridging the digital divide by enhancing access to technology and training for researchers and participants, particularly in underserved regions. Investing in infrastructure improvements, such as internet connectivity and technological literacy, is crucial. Utilizing advanced data management tools and fostering interdisciplinary collaboration can enhance data analysis and interpretation. Finally, ensuring inclusive research practices that consider diverse socio-economic backgrounds and are culturally sensitive will enhance the relevance and applicability of research findings.

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The authors have sufficiently contributed to the study, and have read and agreed to the published version of the manuscript.

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Conflict of interests

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