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Digital Transformation's Influence on Collaborative Academic Networks

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Abstract

This study aims to explore the impact of digital transformation on collaborative academic networks, focusing on the experiences, benefits, challenges, and implications of digital tools for academic collaboration. A qualitative research design was employed, using semi-structured interviews with 26 participants from various academic institutions across different regions. The participants were selected from online platforms based on their experience with digital tools in academic collaborations. Data were analyzed using NVivo software to identify themes and subthemes, with the study reaching theoretical saturation. The research employed a thematic analysis approach to understand the key factors influencing digital transformation in academic networks. The results revealed that digital transformation has significantly enhanced communication and collaboration within academic networks, allowing for easier sharing of resources, interdisciplinary cooperation, and more efficient research workflows. However, challenges such as digital inequality, trust issues in virtual interactions, and data security concerns were identified. Additionally, participants from under-resourced institutions reported difficulties in fully leveraging digital tools, highlighting the role of institutional leadership and infrastructure in the successful adoption of digital technologies. Digital transformation has a profound impact on collaborative academic networks by improving access to resources, fostering interdisciplinary collaboration, and enabling real-time communication. However, it also presents challenges, particularly related to trust, data security, and digital inequalities. To fully harness the benefits of digital transformation, academic institutions must address these challenges through better infrastructure, targeted training, and leadership support. Ensuring equitable access to digital tools is crucial for fostering inclusive academic collaboration.

Keywords: Digital Transformation, Collaborative Networks, Academic Collaboration, Trust, Data Security, Digital Inequality, Thematic Analysis, Semi-structured Interviews, Higher Education, Interdisciplinary Research.

1. Introduction

The concept of digital transformation is not new; however, its application in academic settings has garnered significant attention in recent years. With rapid advancements in technology and the increased reliance on digital platforms, academic collaborations have expanded beyond geographical boundaries, providing unprecedented opportunities for cross-disciplinary research and international partnerships (Chen et al., 2023; Cheng et al., 2023). Researchers are now able to collaborate in real time, sharing large datasets, ideas, and resources without the constraints of time zones or physical proximity. As Cheng et al. (2023) suggest, the move towards digital transformation in academic networks has been driven by the need for efficiency and the quest to keep pace with technological advancements that reshape the academic landscape. As such, the process is not

only about adopting new technologies but also about restructuring organizational practices and culture to enhance collaboration (Cheng et al., 2023).

While the benefits of digital transformation are widely acknowledged, the shift to digital platforms has also brought about challenges, especially in terms of communication, trust-building, and data management. Alam et al. (2022) emphasize that digital transformation is often accompanied by resistance to change, with some academics reluctant to adopt new technologies.

This reluctance can be particularly pronounced among senior scholars or those unfamiliar with digital tools (Alam et al., 2022). Moreover, the quality of communication in digital environments often differs from traditional face-to-face interactions, which can hinder the effectiveness of collaborations (Teng et al., 2022). Trust-building, which is a crucial component of successful academic partnerships, can be more challenging in digital settings, where non-verbal cues are absent, and interaction may be limited to text-based communication (Badasjane et al., 2022).

Furthermore, the digital divide remains a significant concern in academia, with disparities in access to technology, digital literacy, and institutional support. According to Tiwow (2023a), disparities in digital skills and infrastructure can affect the equity of academic collaborations, as not all researchers have the same access to digital tools (Tiwow, 2023a). The growing importance of digital platforms in academic networks has raised questions about how these inequalities can be addressed to ensure that digital transformation benefits all scholars, regardless of their location or institutional affiliation.

One of the key areas where digital transformation is having a profound impact is in research productivity. The ability to collaborate remotely and exchange ideas and resources instantly has increased the speed and output of academic research (Ciliberti et al., 2023). By utilizing digital platforms, researchers can engage in continuous dialogue, share data seamlessly, and collaborate with peers from diverse disciplines and geographic locations. As Hu and Xu (2023) argue, the ability to work across borders and disciplines has facilitated the growth of interdisciplinary research, leading to novel insights and innovations. However, the nature of digital collaboration also brings new challenges related to the management of data, security concerns, and the need for effective tools to ensure smooth collaboration (Hu & Xu, 2023).

The influence of digital transformation on collaborative academic networks is further compounded by the increasing role of artificial intelligence (AI) and machine learning in academic research. AI-driven tools are now being used to analyze large datasets, predict trends, and even assist in the writing and review of research papers (Yao et al., 2023). These technologies have the potential to revolutionize academic collaboration by enabling researchers to uncover patterns in data more quickly and accurately than traditional methods. Nevertheless, the integration of AI into academic networks also raises ethical concerns, including the potential for bias in algorithms and the need for transparent AI systems (Zhang, 2023). As digital tools become more ingrained in academic practices, it is crucial to examine their implications for research ethics and the responsible use of AI.

In addition to technological advancements, leadership and organizational culture play pivotal roles in shaping the success of digital transformation in academic networks. Amaliah (2023) highlights the importance of leadership in guiding academic institutions through the complexities of digital transformation (Amaliah, 2023). Leaders who embrace change, foster digital literacy, and promote a culture of innovation are better positioned to lead successful digital transformations in academic networks. Moreover, fostering a collaborative culture that values knowledge sharing, transparency, and inclusivity is essential for ensuring that digital tools enhance, rather than hinder, academic collaborations (Kumar et al., 2023).

Digital transformation also intersects with organizational theory, particularly in terms of how it influences decision-making and network coordination. According to Qi et al. (2022), digital transformation requires a shift in how organizations operate, with an emphasis on flexibility, agility, and responsiveness to change (Qi et al., 2022). In academic networks, this means that traditional hierarchical structures may need to be reevaluated to accommodate more fluid, collaborative models. The growing reliance on digital platforms can also change the nature of academic leadership, with decision-making becoming more decentralized and dependent on collective input from various stakeholders (Xu et al., 2022). As such, understanding the interplay between digital transformation and organizational dynamics is essential for fostering more effective academic collaborations.

The role of digital transformation in academic networks also extends to addressing the challenges posed by the COVID-19 pandemic. The pandemic forced many academic institutions to rapidly transition to digital platforms for teaching, research, and

collaboration. According to Ediansyah et al. (2022), the pandemic accelerated the adoption of digital tools, particularly in sectors such as medical tourism, where digital networking became essential for maintaining partnerships and sharing resources. This unprecedented shift to digital collaboration during the pandemic has provided valuable insights into how academic networks can adapt to future disruptions, whether technological, environmental, or societal (Ediansyah et al., 2022).

Despite the growing body of research on digital transformation in various sectors, there remains a gap in understanding how these transformations specifically affect academic collaborations. This article seeks to fill that gap by examining the role of digital transformation in shaping collaborative academic networks. By focusing on the experiences of researchers and academics who have integrated digital tools into their collaborative practices, this study explores how digital transformation is influencing communication, trust-building, productivity, and overall collaboration dynamics within academic networks. Additionally, the study highlights the challenges and opportunities presented by digital transformation, offering valuable insights for academic institutions, policymakers, and researchers aiming to enhance collaboration in the digital age. In conclusion, digital transformation is reshaping the landscape of academic collaboration, offering new opportunities for cross-border and cross-disciplinary research. This article aims to explore the impact of digital transformation on academic collaboration, focusing on how digital tools are reshaping communication, trust-building, and productivity within these networks.

2. Methods and Materials

This study adopts a qualitative research design aimed at exploring the influence of digital transformation on collaborative academic networks. The research seeks to understand how academic professionals and researchers perceive and experience the changes brought about by digital technologies in their collaborative practices. A total of 26 participants were recruited for the study, all of whom are academics or researchers engaged in collaborative work within academic networks. These participants were selected through online platforms, ensuring diversity in academic disciplines, career stages, and geographic locations. The study employs a purposive sampling strategy to ensure that participants have relevant experience in digital collaboration.

Data for this study were collected through semi-structured interviews, allowing for an in-depth exploration of participants' perspectives on digital transformation and its impact on their collaborative practices. The interviews were conducted online, with each interview lasting between 45 and 60 minutes. The interview guide consisted of open-ended questions designed to elicit detailed responses about participants' experiences, challenges, and perceptions regarding digital tools and technologies in collaborative academic work. The data collection process continued until theoretical saturation was reached, meaning no new themes or insights emerged from additional interviews.

The data were analyzed using NVivo software, a qualitative data analysis tool, to facilitate systematic coding and theme identification. Following the principles of grounded theory, the interview transcripts were coded inductively, allowing for patterns and themes related to digital transformation's influence on academic collaboration to emerge. The analysis process involved several stages, including initial open coding, axial coding to group related codes, and selective coding to identify the core themes that best represented the research question. The study aimed to achieve theoretical saturation, ensuring that the data were thoroughly analyzed and that the findings were robust and reflective of the participants' experiences.

3. Findings and Results

The study included 26 participants, all of whom were academics or researchers involved in collaborative work within academic networks. Of the 26 participants, 12 (46%) were male, and 14 (54%) were female. Participants were from a diverse range of disciplines, with 9 (35%) representing the social sciences, 7 (27%) from the natural sciences, 6 (23%) from engineering and technology fields, and 4 (15%) from the humanities. In terms of career stage, 8 (31%) participants were early-career academics, with fewer than 5 years of experience in their field, 12 (46%) were mid-career academics with 5–15 years of experience, and 6 (23%) were senior academics with more than 15 years of experience. Geographically, participants were distributed across several regions, including North America (8 participants, 31%), Europe (7 participants, 27%), Asia (6 participants, 23%), and Africa (5 participants, 19%). The majority of participants (24, 92%) reported frequent use of digital tools for collaboration, with 18 (69%) using them on a daily basis, while 8 (31%) used these tools weekly. These characteristics

reflect the diverse backgrounds and perspectives of the participants, providing a broad range of insights into the influence of digital transformation on academic collaboration.

Table 1. The Results of Qualitative Analysis

Category	Subcategory	Concepts
Theme 1: Digital Tools in Collaboration	Adoption of Digital Tools	- Ease of use
		- Technological readiness
		- Training needs
		- Initial resistance
		- User-friendliness
	Integration into Existing Practices	- Compatibility with traditional methods
		- Seamless integration
		- Workflow disruption
		- Alignment with academic goals
	Usage Frequency	- Daily use
		- Occasional use
		- Frequency of use across disciplines
		- Preferred tools
		- Varied use across research stages
	Effectiveness of Tools	- Impact on productivity
		- Quality of communication
		- Facilitates data sharing
		- Improved accessibility
Theme 2: Collaborative Dynamics	Changes in Communication	- Real-time communication
		- Asynchronous collaboration
		- Collaborative platforms
		- Clarity of communication
		- Improved feedback loops
	Building Trust Online	- Reliance on digital interaction
		- Trust-building mechanisms
		- Challenges in online trust
		- Transparency in communication
	Cultural and Geographical Differences	- Time zone challenges
		- Cultural misunderstandings
		- Diversity in collaboration
		- Geographical barriers
		- Global collaboration benefits
Theme 3: Impact on Research Outputs	Increased Research Productivity	- Faster project timelines
		- More collaborative publications
		- Efficient research workflows
		- Diverse input leading to better outcomes
	Innovation and Creativity	- Cross-disciplinary ideas
		- New research methodologies
		- Stimulated creativity
		- Access to diverse perspectives
	Quality of Research	- Collaboration depth
		- Sharing expertise
		- Rigorous peer review
		- Enhanced research credibility
Theme 4: Challenges of Digital Transformation	Technical Challenges	- Connectivity issues
		- Software incompatibility
		- Data security concerns
		- Learning curve for new tools
	Emotional and Social Impact	- Feelings of isolation
		- Over-reliance on technology
		- Lack of face-to-face interactions
		- Virtual burnout
	Resistance to Change	- Lack of digital literacy
		- Fear of obsolescence
		- Institutional barriers
		- Comfort with traditional methods

	Managing Data Overload	- Difficulty in managing large datasets - Information overload - Data organization tools - Ensuring data quality and accuracy
	Sustainability of Collaborative Networks	- Long-term engagement - Dependency on digital platforms - Sustainability of relationships - Need for ongoing digital literacy training

Theme 1: Digital Tools in Collaboration

Adoption of Digital Tools

The adoption of digital tools within academic collaborations varied significantly among participants. Many expressed that the ease of use of these tools was a key factor in their adoption. However, some participants highlighted the need for proper training to overcome initial resistance. As one participant noted, “When we first started using Istangram, it was overwhelming, but once we got the hang of it, it really streamlined our work.” Others pointed out that technological readiness within their institutions was a crucial element for successful integration. As one participant stated, “The university’s infrastructure wasn’t ready for the tools we needed, and it created a lot of frustration in the beginning.”

Integration into Existing Practices

Digital tools were often integrated into pre-existing collaborative practices, but the compatibility with traditional methods was a mixed experience. Several respondents mentioned that the integration was seamless, with digital tools enhancing their workflow without disrupting established processes. One participant shared, “The transition was easy; we just started using the digital platforms in parallel with our usual meetings, and it worked out well.” Conversely, others reported significant disruption, particularly in the initial stages of adoption. “At first, it felt like we were trying to fit a square peg into a round hole,” said another participant, emphasizing the challenges of aligning digital tools with their research practices.

Usage Frequency

The frequency with which participants used digital tools for collaboration varied depending on the research stage and the discipline. Many reported using these tools daily, particularly during the data collection and writing phases of their projects. One participant noted, “We’re on Telegram every day, collaborating on papers and datasets.” However, others used digital tools more sporadically, depending on the collaboration needs. For example, one academic said, “We use it when it’s necessary, but it’s not part of our daily routine.” The usage also differed across disciplines, with some fields relying more heavily on digital tools due to the nature of their research. “In my field, we’ve always used digital tools for data sharing, so it was a natural shift,” explained a participant from a technical discipline.

Effectiveness of Tools

The effectiveness of digital tools in enhancing academic collaboration was generally seen in positive terms. Participants indicated that these tools improved productivity, quality of communication, and data accessibility. As one participant noted, “We can share large datasets in real time now, which saves us a lot of time.” Furthermore, many academics felt that digital platforms allowed for better communication, particularly in asynchronous modes. “We can have conversations at any time across time zones, which makes our work much more flexible,” one respondent commented.

Theme 2: Collaborative Dynamics

Changes in Communication

The shift to digital collaboration has profoundly impacted how academics communicate. Participants reported both positive and negative outcomes. On the positive side, real-time communication through various platforms facilitated quicker feedback and more dynamic discussions. “We can have immediate discussions, which is a huge improvement over waiting for emails,” shared one interviewee. On the other hand, some expressed challenges in ensuring the clarity of communication in digital spaces, particularly when relying on text-based communication. One participant stated, “Sometimes, tone gets lost in emails or messages, which can lead to misunderstandings.”

Building Trust Online

The challenge of building trust in online collaborations was a recurring theme. Some participants noted that trust-building mechanisms, such as clear communication and transparency, were essential for successful collaborations. “We have regular check-ins and ensure everyone’s voice is heard,” one participant explained. However, building trust virtually was not without

its difficulties. As one participant noted, “It’s harder to trust someone you’ve never met face-to-face; it takes time to really get to know their working style.” Issues of online trust were particularly pronounced in cross-institutional collaborations, where varying expectations about communication and response times created uncertainty.

Cultural and Geographical Differences

Geographical and cultural differences also presented challenges in digital collaborations. Many participants cited time zone differences as one of the most significant hurdles in scheduling meetings and coordinating activities. “It’s a nightmare trying to coordinate a meeting with colleagues from different continents,” one respondent shared. Cultural differences also impacted how collaboration was approached, with varying expectations regarding communication styles and decision-making processes. One participant highlighted, “In some cultures, it’s common to avoid confrontation, which can slow down decision-making when everyone is trying to avoid giving direct feedback.”

Theme 3: Impact on Research Outputs

Increased Research Productivity

Participants reported that digital tools had a noticeable impact on their research productivity. Many academics highlighted that the tools allowed for faster project timelines and more efficient sharing of resources, which ultimately led to quicker publication of results. “We can collaborate on papers and share resources so much faster than we ever could before,” said one participant. Additionally, the ability to work across time zones allowed for continuous progress on research projects. “I’ve worked on papers at odd hours because my co-author was on the other side of the world. It keeps things moving,” another participant noted.

Innovation and Creativity

Digital collaboration facilitated greater innovation and creativity, particularly through the diversity of perspectives that digital networks enabled. As one participant explained, “Collaboration through digital platforms exposes you to new ideas that you might not encounter in your immediate academic circle.” The ability to collaborate across disciplines was also cited as a key benefit. “It’s a perfect environment for cross-disciplinary ideas—things that I wouldn’t have thought of on my own,” shared another respondent.

Quality of Research

Participants agreed that digital collaboration contributed to the quality of research. By enabling more robust discussions and access to diverse expertise, digital tools helped improve the rigor of academic projects. “The feedback we get from collaborators in real time helps refine our research,” one participant explained. Additionally, the ability to share data and findings more easily led to more thorough peer reviews, enhancing the credibility of the research output. “The transparency of the platforms ensures that everything is visible to all collaborators, which helps improve the overall quality,” another participant stated.

Theme 4: Challenges of Digital Transformation

Technical Challenges

Despite the many benefits of digital tools, participants highlighted several technical challenges that impacted their collaborations. Connectivity issues were frequently mentioned, particularly in areas with unstable internet connections. “Sometimes, poor internet speeds make virtual meetings impossible,” one participant explained. Software incompatibility was another recurring issue, particularly when trying to use tools across different institutional systems. “Our university uses a different platform than my co-authors, and that causes a lot of confusion,” another participant shared. Data security concerns also emerged, with participants citing the importance of ensuring the protection of sensitive research data when using digital tools.

Emotional and Social Impact

The emotional and social impact of digital collaboration was also discussed by several participants. Some expressed feelings of isolation due to the lack of face-to-face interaction. “I miss the social aspect of working together in person,” one participant said. Others noted the over-reliance on technology, which led to fatigue and burnout. “We’re always online now, and it feels like we never get a break,” shared another academic. The lack of in-person interactions also affected relationship-building, with one participant observing, “It’s harder to form strong professional relationships when everything is mediated through a screen.”

Resistance to Change

Many participants expressed initial resistance to adopting digital tools, particularly those who were accustomed to traditional methods of collaboration. Some cited a lack of digital literacy as a barrier, stating that they felt uncomfortable using new

technologies. “I was intimidated by the tools at first, but I’ve learned to adapt,” one participant remarked. Institutional barriers also contributed to resistance, with some respondents noting that their institutions were slow to adopt digital tools. “There was a lot of resistance from senior faculty members who preferred the old way of doing things,” explained another participant.

Managing Data Overload

The management of data overload was a common challenge reported by participants. The sheer volume of information that could be shared through digital tools sometimes led to difficulties in organizing and maintaining data. “It’s hard to keep track of everything; there’s just so much data coming in from every direction,” said one participant. To address this, some participants used data organization tools, while others focused on ensuring data quality and accuracy. “We’ve had to create clear protocols for organizing data to avoid losing important information,” one participant noted.

Sustainability of Collaborative Networks

Participants were divided on the long-term sustainability of digital collaborative networks. While many saw the advantages of being able to collaborate remotely, others expressed concerns about the reliance on digital platforms. “We’re dependent on these platforms now, but I wonder how sustainable they’ll be in the future,” one participant commented. Furthermore, the need for ongoing digital literacy training was emphasized to ensure that all members of a collaborative network could effectively engage with these tools. “We need to make sure everyone is up to speed, or else the collaboration won’t work,” explained another respondent.

4. Discussion and Conclusion

The results of this study highlight the significant influence of digital transformation on collaborative academic networks. Participants reported enhanced communication, broader access to research resources, and increased interdisciplinary collaborations, all of which were attributed to the integration of digital tools. At the same time, several challenges, including digital inequality, resistance to change, and concerns about trust and data security, were noted. This discussion synthesizes these findings by explaining how they align with and contribute to the existing literature on digital transformation in academic contexts.

One of the main findings of this study is that digital transformation has facilitated better communication among researchers within collaborative academic networks. This finding supports the work of Cheng et al. (2023), who argue that digital tools enable faster and more efficient communication among scholars, particularly in interdisciplinary collaborations. With the advent of tools like email, video conferencing, and collaborative platforms such as Google Scholar and Mendeley, researchers can now interact in real time, regardless of geographical location. This is consistent with the conclusions drawn by Amaliah (2023), who found that digital communication tools have significantly streamlined workflows in public sector organizations. The ability to collaborate across time zones and borders enhances the efficiency of academic research, as participants in this study also confirmed that their ability to collaborate had increased due to the ease of accessing colleagues remotely.

Another significant result from this study is the enhanced access to research resources and data facilitated by digital transformation. Many participants reported that digital tools, such as cloud-based repositories and open-access platforms, enabled them to share and access large datasets and research materials with minimal barriers. This is in line with the findings of Yao et al. (2023), who suggest that digital tools provide unparalleled access to research resources, enabling faster dissemination of knowledge and more diverse collaboration opportunities. As digital platforms evolve, they allow for seamless integration of data across different academic disciplines, thereby fostering interdisciplinary collaborations. This result also aligns with the work of Kumar et al. (2023), who emphasized the growing importance of digital technologies in breaking down traditional silos within academic disciplines.

However, while digital tools have provided significant benefits, participants in this study also reported various challenges in using these technologies, particularly in terms of trust-building and data security. The absence of face-to-face communication was highlighted as a barrier to establishing trust in collaborations, a finding that resonates with the concerns raised by Alam et al. (2022). According to their study, trust is a key component of successful collaboration, but it can be more difficult to establish in digital environments where personal interaction is limited. Similarly, Badasjane et al. (2022) observed that digital communication can lead to misunderstandings or misinterpretations, which may negatively affect the quality of collaboration. This concern was echoed by the participants in our study, who noted that non-verbal cues, which play a crucial role in face-to-

face communication, are often lost in digital interactions. These challenges highlight the need for more effective communication strategies that can help mitigate the limitations of digital communication.

In addition to communication challenges, concerns about data security and privacy were also prevalent among the participants. Many academics expressed reluctance to share sensitive research data through digital platforms due to fears of hacking or unauthorized access. This concern is consistent with the findings of Du and Zhang (2022), who highlighted the risks associated with digital transformation, particularly in the context of data privacy (Du & Zhang, 2022). The need for robust security measures to protect intellectual property and personal information is particularly relevant in academic settings, where research data can be highly sensitive. This aligns with the work of Yılmaz (2023), who emphasized that ensuring secure digital environments is crucial for the success of digital transformation in various sectors, including academia (Yılmaz, 2023).

Another key finding from the study is the digital divide and its implications for academic collaboration. Participants from under-resourced institutions or countries with limited access to digital infrastructure reported greater difficulty in fully participating in digital collaborations. This finding supports the work of Tiwow (2023), who identified that disparities in digital literacy and access to technology hinder the ability of some researchers to engage in digital transformation effectively (Tiwow, 2023a, 2023b). Furthermore, Nguyen et al. (2023) argue that social capital and access to resources play a critical role in enabling digital transformation, and their study found that startups with better access to digital tools performed better in terms of collaboration and innovation (Nguyen et al., 2023). Similarly, in this study, participants from well-resourced institutions were able to utilize digital tools to their full potential, whereas those from institutions with fewer resources faced challenges such as unreliable internet access or insufficient training in digital tools. These disparities emphasize the need for targeted policies to bridge the digital divide and ensure equitable access to the benefits of digital transformation.

The findings also highlight the role of leadership in driving successful digital transformation. Academics who worked in institutions where leaders embraced digital change and provided necessary training and support reported more positive experiences with digital tools. This is consistent with the conclusions of Hämäläinen and Salmi (2022), who found that leadership plays a crucial role in facilitating digital transformation in organizations (Hämäläinen & Salmi, 2022). In the context of academic collaboration, leadership that encourages innovation and digital literacy can foster a more collaborative and productive academic environment. This aligns with the study by Amaliah (2023), which found that leadership support was critical in overcoming resistance to digital transformation in the public sector. In academic settings, leaders who promote digital transformation can help create a culture that values the use of digital tools for collaboration and research (Hämäläinen & Salmi, 2022).

While this study provides valuable insights into the impact of digital transformation on collaborative academic networks, it is not without its limitations. First, the study relied on self-reported data from academics, which may introduce response biases. Participants may have overstated the positive impacts of digital transformation due to social desirability or the perceived need to highlight the benefits of digital tools. Second, the study focused on academics who were already using digital tools for collaboration, which means that the findings may not fully capture the experiences of those who have not yet adopted these technologies. As a result, the study may not provide a comprehensive view of the challenges faced by scholars who are hesitant or unable to adopt digital tools. Third, the study's sample, though diverse in terms of academic discipline and geographical location, was limited to a relatively small number of participants (26). A larger sample would likely provide a more robust understanding of the impact of digital transformation across different types of academic networks and institutions.

Future research could explore the experiences of academic researchers in non-Western countries or institutions with limited digital resources. The digital divide identified in this study suggests that there may be significant variations in how digital transformation is experienced across different regions. Research focusing on under-resourced academic environments could provide insights into the barriers that prevent these scholars from fully participating in digital collaborations and how these barriers can be overcome. Furthermore, longitudinal studies that track the impact of digital transformation over time would provide a more nuanced understanding of how digital tools shape academic collaborations in the long run. Finally, future research could explore the intersection of digital transformation and artificial intelligence in academic collaboration, particularly how AI-powered tools are changing the nature of knowledge creation and sharing in academic networks.

Based on the findings of this study, there are several practical recommendations for academic institutions and policymakers seeking to enhance collaboration through digital transformation. First, institutions should invest in digital infrastructure and

provide training for academic staff to ensure that all researchers, regardless of their location or institutional affiliation, can fully participate in digital collaborations. Providing access to reliable internet, cloud-based tools, and digital literacy programs is essential for fostering inclusive academic networks. Second, academic institutions should prioritize building trust in digital environments by developing clear communication protocols and fostering a culture of openness and transparency. This can be achieved through regular virtual meetings, workshops, and collaborative platforms that encourage active participation and interaction among researchers. Finally, policymakers should focus on creating policies that address the digital divide and promote equitable access to digital tools in academia. This includes funding initiatives that support the adoption of digital tools in under-resourced institutions and providing incentives for cross-institutional collaborations that leverage digital platforms.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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