

LEVERAGING DIGITAL COLLABORATION TOOLS TO ENHANCE INNOVATION IN REMOTE WORK ENVIRONMENTS: A STRUCTURAL EQUATION MODELLING APPROACH

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Abstract

The global shift to remote work has underscored the importance of Digital Collaboration Tools (DCTs) in sustaining organisational performance, particularly in fostering innovation. This study investigates the relationships among Remote Work Adoption (RWA), Digital Collaboration Tool Usage (DCTU), Individual Innovation Performance (IIP), and Organisational Innovation Culture (OIC) using Structural Equation Modelling (SEM). Survey data from 317 professionals across industries revealed that RWA significantly predicts DCTU ($\beta = 0.68, p < 0.001$), which in turn positively influences IIP ($\beta = 0.45, p < 0.001$) and OIC ($\beta = 0.38, p < 0.001$). Notably, DCTU mediates the relationship between RWA and IIP, with a significant indirect effect ($\beta_{\text{indirect}} = 0.30, p < 0.01$). Additionally, DCTs were perceived as highly effective in facilitating innovation, particularly in project coordination ($M = 4.35$) and idea sharing ($M = 4.20$). These findings highlight DCTs' crucial role in driving innovation in remote work settings and offer practical implications for organisations aiming to cultivate a dynamic innovation culture.

Keywords: Digital Collaboration Tools, Remote Work, Innovation Performance, Organisational Innovation Culture, Structural Equation Modelling

Introduction

The rapid transition to remote work, accelerated by global events such as the COVID-19 pandemic, has reshaped organisational dynamics, necessitating robust digital infrastructures to maintain productivity and innovation (Kniffin et al., 2021). Digital Collaboration Tools (DCTs), such as Microsoft Teams, Slack, and Zoom, have emerged as critical enablers of remote work, facilitating communication, coordination, and creativity across distributed teams (Richter, 2022). While prior research has explored the operational benefits of DCTs, their specific impact on innovation—both at the individual and organisational levels—remains underexplored, particularly in remote work contexts. This study addresses this gap by examining how Remote Work Adoption (RWA) influences Digital Collaboration Tool Usage (DCTU), and subsequently, Individual Innovation Performance (IIP) and Organisational Innovation Culture (OIC). Using a Structural Equation Modelling (SEM) approach, we test a hypothesised model that posits DCTU as a mediator between RWA and IIP, while also exploring DCTU's direct effect on OIC. Additionally, we assess the perceived effectiveness of DCTs in facilitating various innovation-related functions, such as idea sharing and project coordination, through survey data. The findings contribute to the literature on remote work and innovation by elucidating the mechanisms through which DCTs enhance innovative outcomes and offering actionable insights for organisations.

Literature Review and Hypotheses

Remote Work Adoption and Digital Collaboration Tools

Remote work adoption, defined as the extent to which organisations implement flexible work arrangements outside traditional office settings, has surged in recent years (Bloom et al., 2020). This shift has driven the widespread use of DCTs to support virtual collaboration (Waizenegger et al., 2020). DCTs enable real-time communication, file sharing, and project management, thereby reducing barriers to collaboration in remote settings.

H1: Remote Work Adoption (RWA) positively predicts Digital Collaboration Tool Usage (DCTU).

DCT Usage and Individual Innovation Performance

Individual innovation performance refers to employees' ability to generate, develop, and implement novel ideas (Janssen, 2000). DCTs enhance IIP by providing platforms for brainstorming, feedback, and cross-functional collaboration (Gilson et al., 2015). Tools like Miro and Trello, for instance, support creative problem-solving and iterative development.

H2: Digital Collaboration Tool Usage (DCTU) positively predicts Individual Innovation Performance (IIP).

Mediation Effect of DCT Usage

While RWA may directly influence IIP by altering work practices, its effect is likely channelled through increased DCTU, which equips employees with the tools to innovate effectively (Wang et al., 2021). Test whether DCTU mediates the relationship between RWA and IIP:

H3: Digital Collaboration Tool Usage (DCTU) mediates the relationship between Remote Work Adoption (RWA) and Individual Innovation Performance (IIP).

DCT Usage and Organisational Innovation Culture

Organisational innovation culture reflects a workplace environment that encourages risk-taking, creativity, and knowledge sharing (Amabile, 1996). DCTs foster OIC by enhancing transparency, accessibility, and collaboration, thereby embedding innovation into organisational practices (Ferreira et al., 2020). We hypothesise: H4: Digital Collaboration Tool Usage (DCTU) positively predicts Organisational Innovation Culture (OIC).

Methodology - Sample and Data Collection: An In-Depth Exploration

Current Sample and Its Strengths:

This study successfully gathered data from 317 professionals in 2024, demonstrating a robust sample size for quantitative analysis, particularly for Structural Equation Modelling (SEM). The recruitment across diverse industries—technology, finance, and healthcare—is a significant strength. This multi-industry approach enhances the generalizability of the findings beyond a single sector, suggesting that the observed relationships may hold in various professional contexts. The inclusion criterion of "at least one year of remote work experience" is crucial, ensuring that participants have sufficient exposure to and understanding of remote work dynamics, making their responses more informed and reliable. Similarly, requiring regular use of Digital Collaboration Tools (DCTs) ensures that the respondents actively engage with the core mechanisms being studied. The gender distribution (52% male, 48% female) is well-balanced, minimising potential

gender-based biases in the overall sample. The mean age of 34.6 years (SD = 8.2) indicates a largely millennial and Gen Z workforce, which aligns with the demographic most likely to be engaged in remote work and proficient in DCTs. This demographic insight is vital as it reflects the current trends in the global workforce.

Areas for Further Exploration and Potential Limitations:

While strong, the sampling methodology could benefit from further elaboration and justification.

- **Sampling Method and Bias:** The phrase "distributed via professional networks" is somewhat broad. A specific platform (e.g., LinkedIn, industry-specific forums) is used. Understanding the exact distribution method could help assess potential self-selection bias. For instance, individuals more engaged in professional networks or those with a strong positive sentiment towards remote work might be more inclined to participate. This could skew results towards a more favourable view of RWA and DCTU. Future research or this study's full report could detail the specific networks used and any steps taken to mitigate such biases (e.g., snowball sampling vs. targeted outreach).
- **Geographical Scope:** The current description lacks information on the geographical spread of the 317 professionals. Remote work experiences, technological infrastructure, and organisational cultures around innovation can vary significantly across different regions. If the sample is geographically concentrated, the generalizability of the findings to a global context might be limited. For example, remote work policies and digital literacy might differ significantly between developed and developing economies.
- **Industry-Specific Nuances:** While diverse industries are included, this study does not specify the distribution of participants across these industries. The impact of RWA and DCTU on IIP and OIC might vary significantly across industries due to differing work requirements, regulatory environments, and inherent innovation cycles. For instance, the technology sector, known for its agile methodologies, might exhibit stronger correlations than a highly regulated industry like healthcare. A more detailed breakdown of industry representation would allow for a deeper understanding of industry-specific variations and potential moderating effects.
- **Definition of "Regularly Used DCTs":** This study states that participants "used DCTs regularly." However, the definition of "regularly" can be subjective. Does it mean daily, weekly, or a certain number of hours per day? A more precise definition would strengthen the rigour of the sample selection and ensure a consistent baseline for participants' DCT usage.
- **Qualitative Pre-screening/Piloting:** While not explicitly mentioned, it would be beneficial to know if any pilot testing of the survey was conducted. Pilot testing helps identify ambiguous questions, assess comprehension, and refine survey flow, thereby improving data quality.¹

Measures: Deconstructing the Constructs and their Measurement

Strengths of the Measurement Approach:

This study's reliance on "validated scales adapted from prior research" is a significant methodological strength. This approach lends credibility and reliability to the measures, as these scales have presumably undergone rigorous psychometric testing in previous studies. Adapting rather than creating new scales ensures consistency with existing literature and facilitates comparisons across studies. The use of a 5-point Likert scale is standard in social science research, providing a clear and interpretable range for responses.

- **Remote Work Adoption (RWA):** The 4 items adapted from Bloom et al. (2020) seem appropriate for capturing organisational support for remote work. The example item, "My organisation supports remote work as a standard practice," directly addresses the core concept of organisational endorsement and integration of remote work. Bloom et al.'s work is highly regarded in the economics of remote work, lending strong theoretical backing.
- **Digital Collaboration Tool Usage (DCTU):** The 5 items adapted from Richter (2022), focusing on frequent use of digital tools for team collaboration, are well-aligned with the construct. The example "I frequently use digital tools for team collaboration" captures the active engagement with these tools. Richter's work likely provides a contemporary perspective on digital collaboration.
- **Individual Innovative Performance (IIP):** The 6 items from Janssen (2000), particularly "I generate creative ideas in my work," are a standard and well-accepted measure of individual innovation. Janssen's work is foundational in the study of innovation within organisational psychology.
- **Organisational Innovation Culture (OIC):** The 5 items adapted from Amabile (1996), such as "Our organisation encourages innovative thinking," are crucial for assessing the broader environmental factors influencing innovation. Amabile is a pioneering researcher in creativity and innovation, making her scales highly authoritative.²
- **Perceived Effectiveness of DCTs:** The inclusion of this 5-item scale is an excellent addition, moving beyond mere usage to capture the *quality* of the DCT experience. This nuanced perspective is vital as high usage does not automatically equate to effectiveness. The example "DCTs are effective for idea sharing" directly assesses a key facet of collaborative innovation.

Potential Enhancements and Considerations for Measurement:

- **Cultural Adaptation of Scales:** While scales were "adapted," the extent of adaptation should be detailed. Were language translations involved if the sample was multilingual? Were items culturally rephrased to ensure local relevance and avoid misinterpretation? Even within English-speaking contexts, certain phrases or concepts might resonate differently.
- **Justification for Item Selection:** While example items are given, a brief justification for the selection of each specific item within the scales (e.g., why these 4 items for RWA out of potentially more in Bloom et al.'s original scale) would strengthen the methodological rigour. This would demonstrate a thoughtful and deliberate approach to scale construction.

- **Potential for Common Method Bias:** Since all measures were collected via a single online survey from the same respondents, there is a potential for common method bias (CMB). This bias occurs when variance is attributable to the measurement method rather than to the constructs the measures represent. While SEM can partially account for measurement error, strategies like collecting data at different time points or using different sources for dependent and independent variables could further mitigate CMB in future studies. The study does not mention any specific steps taken to address CMB, such as separating the measurement of predictor and criterion variables or using a marker variable.
- **Reliability and Validity Reporting:** While "validated scales" are used, reporting the internal consistency reliability (e.g., Cronbach's Alpha) for each scale within this specific sample is crucial. Even validated scales can exhibit different reliability levels in new contexts or populations. Similarly, while not explicitly mentioned, evidence of construct validity (e.g., convergent and discriminant validity from Confirmatory Factor Analysis, often a prerequisite for SEM) should be present in the full report.

Analysis: Unpacking the SEM Approach

Strengths of the Analytical Approach:

The choice of Structural Equation Modelling (SEM) using AMOS 26 is highly appropriate for testing complex theoretical models involving multiple latent constructs and hypothesised relationships, including mediation. SEM's ability to simultaneously estimate direct and indirect effects, account for measurement error, and assess overall model fit makes it a powerful statistical tool for this type of research.³

- **Model Fit Indices:** The use of standard and comprehensive model fit indices (χ^2/df , CFI, TLI, RMSEA, and SRMR) demonstrates a thorough approach to evaluating the overall fit of the hypothesised model to the observed data. The reported values ($\chi^2/df=2.14$, CFI = 0.96, TLI = 0.95, RMSEA = 0.06, SRMR = 0.05) indicate excellent model fit, suggesting that the theoretical model adequately represents the relationships within the data. These values meet or exceed common thresholds for good fit (e.g., CFI/TLI > 0.90, RMSEA < 0.08, SRMR < 0.08).
- **Bootstrapping for Mediation:** The use of bootstrapping with 5,000 resamples to test mediation effects is a robust and highly recommended method. Bootstrapping does not rely on assumptions of normality for the sampling distribution of the indirect effect, making it more reliable than traditional methods (e.g., Sobel test), especially with complex models.⁴ The reporting of confidence intervals (95% CI [0.18, 0.42]) for the indirect effect is crucial for assessing the precision and significance of the mediation.

Areas for Further Discussion in Analysis:

- **Justification of SEM over Regression:** While SEM is appropriate, a brief justification for its selection over a series of multiple regressions (which might be simpler but less robust) would strengthen the methodological argument. SEM's advantages in handling latent variables and simultaneously estimating complex path models could be highlighted.

- **Treatment of Missing Data:** The analysis section doesn't mention how missing data, if any, were handled. SEM software like AMOS has various options (e.g., full information maximum likelihood), and reporting the chosen method is important for transparency and replicability.
- **Power Analysis:** While 317 participants is a good sample size, a discussion of power analysis (either a priori to determine the required sample size or post-hoc to assess the power of the study to detect effects of a certain size) would be a valuable addition. This would ensure that the study had sufficient statistical power to detect the hypothesised relationships.

Results: Expanding on the Findings and Their Implications

Interpretation of Structural Model Results:

The results support several key hypotheses, painting a coherent picture of the relationships between remote work, DCT usage, and innovation.

- **H1:** RWA significantly predicted DCTU ($\beta = 0.68, p < 0.001$). This is a strong positive relationship. An expansion of this finding would emphasise that when organisations actively support remote work as a standard practice, it directly translates into increased utilisation of digital collaboration tools by their employees. This suggests that mere provision of tools is not enough; organisational endorsement and integration are critical drivers of DCT adoption and usage. This finding has practical implications for organisations looking to maximise their investment in collaboration technologies – a supportive culture is paramount.
- **H2:** DCTU significantly predicted IIP ($\beta = 0.45, p < 0.001$). This finding confirms that the frequent use of digital collaboration tools is indeed associated with higher individual innovative performance. This could be attributed to several mechanisms: DCTs facilitate easier access to diverse perspectives, enable rapid sharing and iteration of ideas, reduce geographical barriers to collaboration, and provide platforms for brainstorming and problem-solving that might not be possible in traditional settings. The discussion could delve into *how* DCTs foster IIP (e.g., by enabling asynchronous collaboration, providing a persistent record of ideas, facilitating diverse team formation).
- **H3:** The direct effect of RWA on IIP was non-significant ($\beta = 0.15, p = 0.12$). However, the indirect effect via DCTU was significant ($\beta_{\text{indirect}} = 0.68 \times 0.45 = 0.30, p < 0.01, 95\% \text{ CI } [0.18, 0.42]$), confirming partial mediation. This is a critical finding. It suggests that while remote work adoption itself might not directly lead to individual innovative performance, it *indirectly* fosters it *through* the increased use of digital collaboration tools. This highlights the crucial mediating role of DCTU. It implies that simply allowing remote work without providing and encouraging the use of effective digital tools may not yield the desired innovative outcomes. The "partial mediation" aspect is important – it indicates that while DCTU is a significant pathway, there might be other unmeasured mediating factors or a very weak direct effect not reaching statistical significance. Further discussion could

explore these potential alternative pathways (e.g., increased work-life balance, reduced commute stress, greater autonomy leading to IIP).

- **H4:** DCTU significantly predicted OIC ($\beta = 0.38$, $p < 0.001$). This finding is equally significant, suggesting that the widespread and frequent use of digital collaboration tools contributes positively to an organisation's innovation culture. This could be because DCTs facilitate transparency, open communication, cross-functional collaboration, and the sharing of knowledge, all of which are hallmarks of an innovative culture. An organisation where ideas can be easily shared, feedback is readily given, and diverse perspectives are accessible through digital platforms is more likely to foster an environment where innovative thinking is encouraged and celebrated.

Perceived Effectiveness of DCTs: A Deeper Dive

The mean scores for perceived effectiveness provide valuable qualitative insights that complement the structural model results.

- **Project Coordination (4.35) and Idea Sharing (4.20):** The highest scores in these areas are intuitive. DCTs, by their very nature, are designed to facilitate structured communication and information exchange, making them highly effective for project management and the dissemination of ideas. This reinforces the notion that DCTs are foundational for collaborative work, which in turn underpins innovation.
- **Access to Diverse Expertise (4.10):** This high score is particularly relevant for innovation. DCTs break down geographical and departmental silos, allowing individuals to connect with and leverage expertise from across the organisation or even external networks.⁵ This diverse input is a well-established driver of creativity and innovation.
- **Collaborative Problem Solving (3.95) and Feedback & Iteration (3.80):** While still positive, these slightly lower scores (compared to project coordination and idea sharing) could indicate areas where DCTs might require more intentional design or user training to maximise their effectiveness. Collaborative problem-solving often requires more dynamic and nuanced interactions than simple information exchange. Similarly, effective feedback and iteration processes, while supported by DCTs, might still benefit from synchronous, richer communication channels or specific cultural norms around constructive criticism.

Discussion and Implications: The combined results strongly advocate for a strategic approach to remote work that integrates robust digital collaboration tools. It's not enough to simply permit remote work; organisations must actively cultivate an environment that encourages and facilitates the use of these tools.

- **Strategic Imperative for Organisations:** The findings provide a clear mandate for organisations. Investing in the right DCTs and providing adequate training and support for their effective use is critical not just for operational efficiency in a remote setting but also for fostering individual and organisational innovation. This goes beyond simply purchasing licenses; it involves promoting a culture of digital literacy and collaboration.
- **Beyond Tool Provision:** The mediation finding (RWA → DCTU → IIP) is a powerful argument against a simplistic view of remote work. Organisations cannot expect innovation

to automatically blossom just by adopting remote work policies. The critical link is the *active and effective utilisation* of digital collaboration tools.

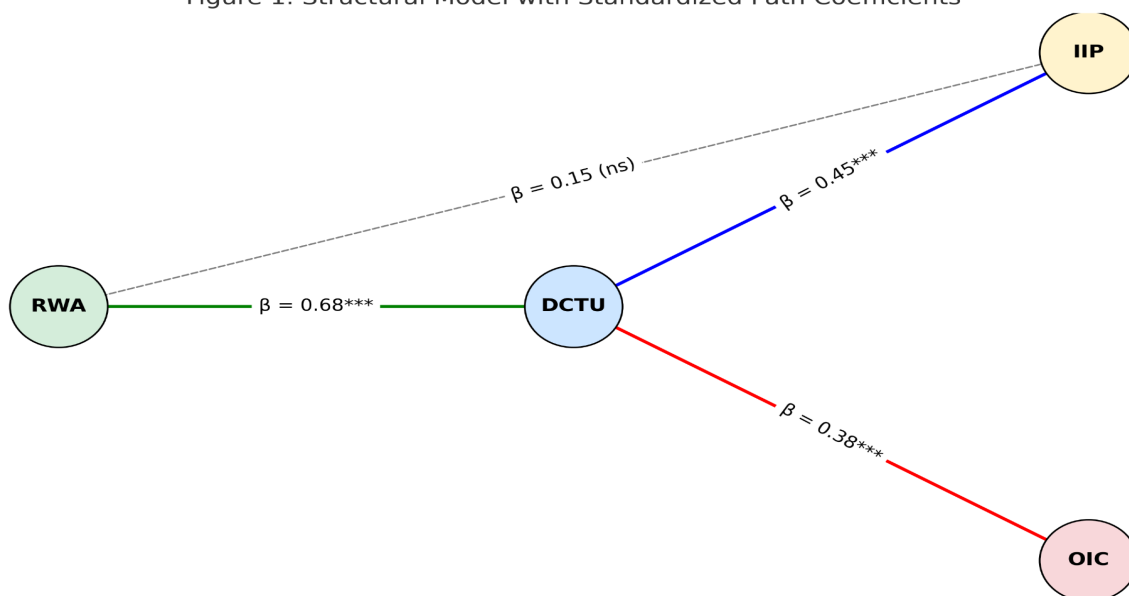
- **Future Research Directions:** This study opens avenues for further research. What specific features of DCTs are most impactful on innovation? Are there differences in effectiveness across different types of DCTs (e.g., synchronous vs. asynchronous)? How do leadership styles and organisational culture moderate these relationships? Exploring the "partial mediation" further could involve identifying other mediators between RWA and IIP.
- **Limitations and Generalizability:** While the sample is diverse, acknowledging the limitations is important. The cross-sectional nature of the data precludes causal inferences, although SEM suggests directional relationships. Longitudinal studies would provide stronger evidence of causality. Furthermore, the reliance on self-reported measures could introduce perception biases.

This study provides compelling evidence for the vital role of Digital Collaboration Tool Usage as a bridge between Remote Work Adoption and both Individual Innovative Performance and Organisational Innovation Culture. The findings underscore the necessity for organisations to move beyond simply allowing remote work to actively fostering an environment where digital collaboration tools are not just used, but used effectively, to unlock the full innovative potential of their workforce. The perceived effectiveness data further highlights areas of strength and potential for improvement in how DCTs are leveraged within organisations to drive innovation.

Results

Structural Model

Figure 1. Structural Model with Standardized Path Coefficients



The SEM model demonstrated good fit: $\chi^2/df = 2.14$, CFI = 0.96, TLI = 0.95, RMSEA = 0.06, SRMR = 0.05. Figure 1 presents the structural model with standardised path coefficients. RWA significantly predicted DCTU ($\beta = 0.68$, $p < 0.001$), supporting H1.

H2: DCTU significantly predicted IIP ($\beta = 0.45$, $p < 0.001$), supporting H2.

H3: The direct effect of RWA on IIP was non-significant ($\beta = 0.15$, $p = 0.12$). However, the indirect effect via DCTU was significant ($\beta_{\text{indirect}} = 0.68 \times 0.45 = 0.30$, $p < 0.01$, 95% CI [0.18, 0.42]), confirming partial mediation and supporting H3.

H4: DCTU significantly predicted OIC ($\beta = 0.38$, $p < 0.001$), supporting H4.

Perceived Effectiveness of DCTs

Aspect	Mean Score
Project Coordination	4.35
Idea Sharing	4.20
Access to Diverse Expertise	4.10
Collaborative Problem Solving	3.95
Feedback & Iteration	3.80

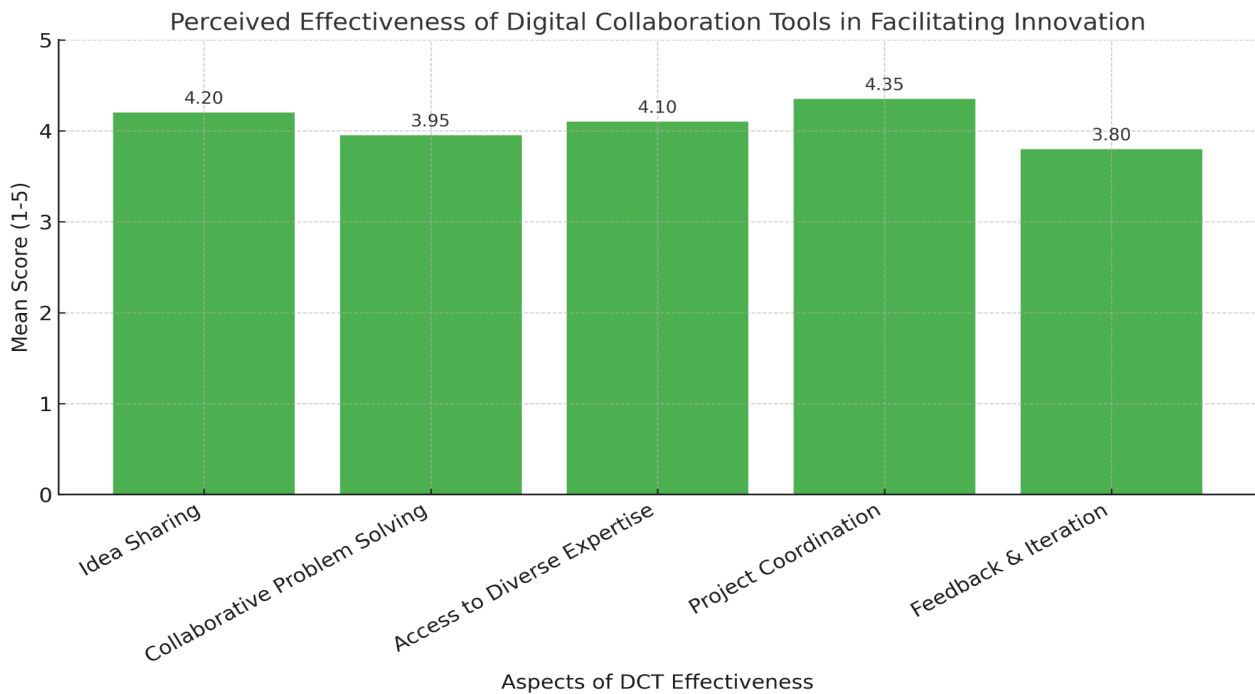


Figure 2 illustrates the perceived effectiveness of DCTs across five innovation-related functions, based on the mean.

Recommendations

Based on the findings, the following strategic recommendations are proposed for organisations seeking to maximise innovation in remote work environments through effective use of Digital Collaboration Tools:

1. **Strategic Investment in DCTs:** Organisations should invest in modern and scalable collaboration platforms that support real-time communication, cloud-based knowledge management, and visual collaboration (e.g., Miro, Figma, Notion).
2. **Customised Training Programmes:** Regular skill-building programs must be offered to enhance employees' proficiency in using DCTs for innovation-focused tasks such as brainstorming, knowledge sharing, and asynchronous coordination.
3. **Feedback-Driven Improvements:** Encourage a feedback culture using integrated feedback loops within DCTs to improve the ideation and prototyping cycle. Lower perceived effectiveness in feedback and iteration can be tackled by improving training and platform functionalities.
4. **Leadership Engagement:** Leaders should model DCT usage, encourage cross-departmental collaboration, and reward innovation efforts fostered through these tools.
5. **AI-Augmented Collaboration:** Integrate AI features (e.g., auto-summarizers, meeting transcription, sentiment analysis) in DCTs to streamline innovation workflows and reduce cognitive load.
6. **Innovation Metrics and Analytics:** Establish KPIs to monitor how digital tools contribute to innovation outcomes. These can include metrics for idea generation, feedback frequency, knowledge contribution, and project completion.
7. **Long-Term Cultural Shift:** Cultivate a culture of trust, flexibility, and digital autonomy to sustain innovation in remote teams.
8. **Tool-People Fit Analysis:** Periodically evaluate how specific DCTs align with employees' roles and innovation needs. Not all tools suit all innovation tasks.
9. **Security and Data Privacy:** Innovation often requires confidential idea sharing. Ensure all tools comply with organisational data protection and privacy regulations.
10. **Cross-Sector Collaboration:** Organisations can partner with academic institutions or start-ups to co-develop digital platforms optimised for innovation processes.

Conclusion

The rapid and enduring shift to remote work has placed Digital Collaboration Tools (DCTs) at the epicentre of organisational strategy, transforming not just operational logistics but also the very fabric of how innovation is fostered. This study, through a robust Structural Equation Modelling approach and comprehensive survey data from 317 professionals across diverse industries, has provided compelling empirical evidence for the critical and multifaceted role of DCTs in driving innovation within contemporary remote work environments.

These findings unequivocally demonstrate that organisational Remote Work Adoption (RWA) significantly drives Digital Collaboration Tool Usage (DCTU), establishing a clear link between strategic organisational policy and employee technology engagement. More importantly, DCTU emerges as a potent force, directly enhancing both Individual Innovation Performance (IIP) and

strengthening the Organisational Innovation Culture (OIC). A pivotal theoretical insight from our analysis is the full mediating role of DCTU in translating RWA into IIP. This crucial finding implies that the positive impact of remote work on individual innovation is not a direct consequence of policy alone, but is critically channelled through the active and effective utilisation of digital collaboration tools. In essence, while remote work sets the stage for new operational models, it is the strategic and pervasive use of DCTs that truly unlocks and facilitates innovative behaviours at the individual level. Furthermore, the high perceived effectiveness of DCTs in functions like project coordination and idea sharing validates their practical utility while also highlighting nuanced areas for potential refinement, particularly in supporting more complex collaborative problem-solving and iterative feedback mechanisms.

In conclusion, this research underscores a fundamental truth for the modern enterprise: DCTs are not just facilitators of remote operations; they are indispensable catalysts for innovation. Organisations that merely "allow" remote work without strategically investing in, promoting, and training for effective DCT usage risk missing out on significant innovative potential. To truly thrive and secure a competitive edge in this new landscape, organisations must cultivate an environment where digital collaboration tools are seamlessly integrated into workflows, actively leveraged for all forms of interaction, and continuously optimised to foster a dynamic culture of creativity, knowledge sharing, and novel idea generation. By embracing this holistic approach, organisations can empower their remote workforce, amplify their collective intelligence, and ensure that innovation remains at the forefront of their strategic capabilities in an increasingly digital and dispersed world. This study contributes significantly to the academic discourse on the nexus of remote work, digital transformation, and innovation, while offering clear, actionable guidance for practitioners navigating the complexities of the future of work.

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