Empowering online modalities in the universities within the post-Covid-19 and 4IR Era: the psychological, behavioral, and technological impacts

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A B S T R A C T

The psychological, behavioral, and technological impacts of adopting online modalities in the Universities within the post-COVID-19 and 4IR era were assessed in this paper. The current researcher obtained informed consent from the 125 academic staff members from five universities in four provinces—the University of Pretoria, University of Johannesburg, Durham University of Technology, University of Western Cape, and North-West University—through a cross-sectional survey methodology. This study’s researcher promoted voluntary participation and ensured ethical standards were respected. In total, 116 surveys were located and completed. Statistical Packages for Social Sciences (SPSS) version 29 was used to clean and analyze the data. This study illustrates how willingness to use online modalities inside universities during the post-COVID-19 and Fourth Industrial Revolution (4IR) is highly influenced by a readiness to change, innovative work behavior, and technological competence. This study demonstrated that adopting online modalities in South African universities during the post-COVID-19 and 4IR periods was significantly influenced by technological proficiency, innovative behavior, and willingness to change.

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Introduction

Since its outbreak in the latter part of 2019, the COVID-19 pandemic, brought on by the brand-new coronavirus SARS-CoV-2, has significantly affected the entire planet. In December 2019, the virus was thought to have started in Wuhan, China. It swiftly spread throughout China and then to other countries (Wang et al., 2020). Countries used various tactics, such as mass testing, contact tracing, quarantine measures, lockdowns, and vaccine programs, to lessen the effects of COVID-19. Much emphasis was also placed on non-pharmaceutical therapies such as social isolation, mask use, and hand hygiene. This pandemic significantly affected numerous industries, including healthcare, education, transportation, and the world economy (Oliver et al., 2021).

Besides, there has been a significant influence of COVID-19 on universities all across the world. Universities quickly transitioned from conventional in-person training to distance learning techniques. This transformation presented considerable hurdles regarding teacher development, student involvement, and technical infrastructure (Hodges et al., 2021). The pandemic has also made existing inequalities in the higher education system worse. Accessing online resources, dependable internet connections, and a supportive learning environment provided extra barriers for students from marginalized backgrounds and low-income households (Hodges et al., 2021).

The Fourth Industrial Revolution (4IR) alludes to the technological revolution changing people’s economy, the industrial landscape, and everyday life (Schwab, 2016; World Economic Forum, 2020). Automation, artificial intelligence, robotics and automation, and
the Internet of Things (IoT) developments are transforming different sectors in a country. While the 4IR creates new economic opportunities, it also presents difficulties like job loss and increased inequality. In addition, the 4IR can improve the quality of life by improving medical care, educational opportunities, and resource management (Marr, 2021).

Universities worldwide have been significantly impacted by the 4IR, which has changed numerous facets of instruction and research. Modern technologies, including artificial intelligence (AI), robotics, blockchain, and the Internet of Things (IoT), have been incorporated into university courses (International Commission on the Futures of Education, 2020). In the 4IR age, the educational environment now includes essential elements, including online learning platforms, virtual classrooms, and digital materials (Educause, 2021). Also, to improve students' employability, universities collaborate with businesses to create research projects, offer internships, and offer work-integrated learning opportunities (World Economic Forum Boston Consulting Group, 2018).

In the post-COVID-19 era, technology facilities like video conferencing, learning management systems, and online collaboration platforms have been upgraded because they have made remote teaching and learning easier (Bhattacharya & Sharma, 2020). The capability of a university to successfully deliver online programs is greatly influenced by the availability and caliber of its technology infrastructure [9]. Also, teachers' opinions of how online modalities affect student engagement and learning results may affect their readiness to use them (Li & Xue, 2023).

The Post-Covid-19 and 4IR era has resulted in tremendous changes and problems for education, society, economies, and people worldwide. It has increased the requirement for readiness and adaptability. Organizations and individuals must adopt digital technologies and solutions for remote work, online collaboration, e-commerce, telemedicine, and other uses due to the Covid-19 pandemic (World Economic Forum, 2020). Besides, the popularity of remote work and flexible work schedules has surged due to the pandemic. Hence, a change in management strategies and skills is needed to manage remote teams successfully during this transformation (Sneader & Singhal, 2020). Additionally, in the age of rapid technological innovation, people must adopt the value of lifelong learning and adjust to changing skill needs.

Universities have embraced innovative work behavior throughout the post-COVID-19 and 4IR (Fourth Industrial Revolution) era to adapt to the changing environment and benefit from technological improvements. Faculty and staff are encouraged to use digital tools and platforms for remote project management, collaboration, and communication (Ramayah & Ibrahim, 2021). Also, utilizing learning management systems, video conferencing tools, and interactive online platforms, universities have adopted blended learning models that integrate in-person education with online components (Hsu & Chiu, 2021). Besides, universities achieve the exchange of ideas, promotion, and improvement of creativity in research and scholarship due to collaborative digital platforms (Bozeman & Boardman, 2014).

Technology proficiency has become essential for universities to adapt to the new normal and prepare students for the digital age in the post-COVID-19 era (Hasnain Baber, 2023). As a result, colleges quickly switched from traditional classroom-based instruction to online learning models. According to (Hodges et al., 2020), this transformation has necessitated that educators acquire digital skills and use various techniques, including video conferencing tools, learning management systems, and online collaboration platforms. Other immersive technologies, including virtual reality (VR) and augmented reality (AR), are used in hybrid classrooms to provide students with exciting and dynamic learning opportunities (Cleveland-Innes et al., 2018).

Universities in African nations (such as South Africa) are now faced with the challenges of making judgments about ensuring continuity in efficiency and goal achievement with the introduction of the 4IR and the post-COVID-19 era.

Studying the many challenges that universities in African nations (such as South Africa) may confront while making decisions about assuring consistency in effectiveness and goal achievement through the implementation of online modalities makes sense. This study explores a few drivers of universities’ acceptance of online modalities in South African institutions to establish a realistic starting point for adopting and maintaining the adoption of online modalities in the post-COVID-19 and 4IR periods.

The topic and aim of this paper are introduced and stated. The literature on the following ideas will be reviewed: readiness for change, innovative work behavior, technological competence, and adoption of online modalities. The study's methodology (a cross-sectional survey methodology) and findings are presented in the following paragraphs. It will then go over its conclusions, practical implications, and contributions. In addition, the investigation's results and advice will be presented.

**Literature Review**

This literature review explores the psychological, behavioral, and technological impacts of adopting online modalities in the Post-Covid-19 and 4IR era.

**Readiness for Change and Adoption of Online Modalities**

The fourth industrial revolution (4IR) and the COVID-19 pandemic have impacted higher education institutions worldwide. South African universities had to adopt digital tools and platforms swiftly to negotiate the post-pandemic world and adjust to the quick improvements brought on by the 4IR. The level of change readiness differed among institutions, though. Several universities' pre-existing infrastructure and technology capabilities made a smoother transition possible. Others encountered difficulties due to scarce resources, poor infrastructure, and a lack of digital literacy among teachers and students (Azionya & Nhedzi, 2021).
The implementation of online modalities is substantially impacted by the universities in South Africa's post-COVID-19 and 4IR (Fourth Industrial Revolution) preparation for change. The conversion of various universities in South Africa to online instruction has brought to light the significance of being open to change to encourage the adoption of online learning platforms and resources (Make et al., 2021). Additionally, Mhlanga (2022) discovered that during the COVID-19 pandemic, more change-ready universities were more successful in switching to online modalities. According to Ng’ambi et al. (2016), universities with proactive policies and strategies for online learning were more likely to accept and successfully incorporate online modalities. Therefore, developing a supportive climate for adopting online modalities depended critically on the willingness of the university administration, academics, and support staff. Additionally, (Mncube et al., 2019) noted that factors like infrastructure, technological support, faculty training, and student support services impacted the adoption and implementation of e-learning in their study on the institutional readiness for technology in South African universities. Based on the information mentioned above, the following hypothesis is made:

\[ H_2: \] In the post-COVID-19 and 4IR, universities’ adoption of online modalities in South Africa is significantly influenced by their readiness to change.

Innovative Work Behavior and Adoption of Online Modalities

Innovative work behavior is the proactive and imaginative activity of people inside an organization that helps to develop and implement new concepts, procedures, or goods. The adoption and integration of online modalities, crucial for negotiating the opportunities and challenges posed by the 4IR, can be sparked by innovative work behavior in the context of universities. According to (Marcolin & Guarino, 2020), people who demonstrated more innovative work behavior were more likely to explore and experiment with new technologies, which led to a rise in the use of e-learning modalities. This illustrates how innovative work behavior positively influences the use of online modalities in universities throughout the post-COVID-19 and 4IR eras. De Jong et al. (2021) also discovered that adopting online learning was significantly predicted by an organizational climate that supported innovative work behavior. As a result, when colleges reward and support creative work practices, it fosters a culture where professors and staff are encouraged to investigate and implement online modalities, ultimately leading to their adoption. IWB has considerably impacted the adoption of online modalities in the context of universities in South Africa during the Fourth Industrial Revolution (4IR) and post-COVID-19 times. Getting academic staff and instructional designers to adopt cutting-edge techniques like project-based learning, blended learning, and flipped classrooms supported by online modalities (Anser et al., 2020). Universities have also created online courses and programs that address various learner needs, including those of working professionals, students in remote locations, and people with physical disabilities (Lubinga et al., 2023). The following postulation was developed in light of the information above:

\[ H_3: \] Innovative Work Behavior significantly impacts universities; adoption of online modalities in South Africa, according to the Post-COVID-19 and 4IR periods.

Technological Competence and Adoption of Online Modalities

The COVID-19 pandemic and 4IR have significantly impacted the adoption of online modalities in universities. This transition has been driven mainly by technological competence, described as the capacity of individuals and organizations to use effectively and leverage technology (Hodges et al., 2020). When the COVID-19 pandemic struck, universities with strong technology capabilities were more ready to switch to online instruction. They have the facilities, equipment, and know-how to quickly convert their teaching and learning procedures to online platforms. According to (Hodges et al., 2020), this proficiency helped prevent disruptions and maintain school continuity. Additionally, technological competence enables universities to broaden access to education beyond conventional boundaries, reaching a wider audience, including students in far-flung locations, working professionals, and people with mobility issues (Fernández-Batanero et al., 2021). Besides, technological proficiency made it possible to create hybrid learning methods, which blend online and in-person teaching. Universities with excellent technical capabilities effortlessly combined online and off-campus instruction, giving students the freedom and individualized learning paths. According to (Fernández-Batanero et al., 2021), this integration encouraged a more integrated and flexible educational approach. Technology proficiency is essential for the successful adoption of online modalities in the setting of South African universities. It enables flexible learning schedules and personalized methods by facilitating the design and distribution of self-paced modules, adaptive learning systems, and customized content matched to individual student's requirements and learning styles (De La Harpe et al., 2021). Following are some hypotheses made in light of the information cited above:

\[ H_c: \] Technological competence significantly influences universities’ adoption of online modalities in South Africa during the Post-Covid-19 and 4IR periods.

\[ H_e: \] Readiness to change, innovative work behavior, and technological competence all have a significant and combined impact on ensuring the adoption of online modalities within South Africa’s universities during the post-COVID-19 and 4IR periods.

Research and Methodology

Through a cross-sectional survey methodology, the current researcher obtained informed consent from the one hundred and Twenty-Five (125) academic staff members from five (5) universities from four (4) provinces who make up the study's respondents: The University of Pretoria, University of Johannesburg, Durban University of Technology, University of Western Cape, and North-West University. The current researcher encouraged voluntary participation and ensured that moral standards were upheld. There were 116
surveys in total, which were located and properly concluded. The data was cleaned and analyzed using SPSS version 29 (Statistical Packages for Social Sciences). However, to create a suitable instrument and acknowledge the local dependability of the measure, this research conducted factor and reliability studies.

The survey for this study includes the following sections:

Section A: Respondents’ demographics

The respondents’ demographic data, including age, gender, level of education, and years of work experience, is covered in this section.

Section B: Readiness to change Scale (RtCS)

This study used the readiness for change scale from Aboobaker and Zakkariya (2021). The instrument contains three components. The dependability coefficient for the entire measure was $\alpha=.75$. However, the current investigation arrived at a coefficient of $\alpha=.80$. A 5-point Likert-style answer scale was used for each statement. One example of a scale item is “I look forward to change at my institution.”

Section C: Innovative Work Behavior Scale (IWBS)

The participants’ perceptions of their IWB are the focus of this measurement. The innovative work behavior measure was developed based on research (Kleysen & Street, 2001). With a dependability coefficient of $\alpha = .94$, it had 14 statements. However, the current study achieved a reliability coefficient of $\alpha = .90$. There are five options on this 5-point Likert scale. “In your current job, how often do you look for opportunities to improve an existing process, technology, product, service, or work relationship?” is an example of the scale items.

Section D: Technological Competence Scale (TCS)

The study adopted a 7-item technological competence measure (Bandura, 2006). Sample items include: “If I try hard enough, I’ll be able to handle any new technology.” and “I perceive myself as a person who understands technology.” The measure’s initial alpha coefficient was equal to $\alpha = 0.87$. The present study’s reliability coefficient for the scale was $\alpha = .89$. This scale has a 5-point Likert answer layout.

Section E: Willingness to Employ Online Modalities Scale (WiEOMS)

Measures of willingness to use online modalities are part of this unit. This scale was used in the investigation by (Budur et al., 2021). It was divided into eight sub-sections and included a total of 24 items: Resource Readiness (3 items), Cultural Readiness (3 items), Strategic Readiness (3 items), IT Readiness (3 items), Innovation Valance (3 items), Cognitive Readiness (3 items), Partnership Readiness (3 items), and Innovation Implementation Effectiveness (3 items). The reliability coefficients for Resource Readiness, Cultural Readiness, Strategic Readiness, IT Readiness, Innovation Valance, Cognitive Readiness, Partnership Readiness, and Innovation Implementation Effectiveness were $\alpha = 0.94$, $\alpha = 0.92$, $\alpha = 0.93$, $\alpha = 0.88$, $\alpha = 0.94$, $\alpha = 0.96$, $\alpha = 0.97$, and $\alpha = 0.91$, respectively. This study found a dependability coefficient of $\alpha = 0.92$, $\alpha = 0.93$, $\alpha = 0.91$, $\alpha = 0.90$, $\alpha = 0.92$, $\alpha = 0.97$, $\alpha = 0.90$, and $\alpha = 0.93$ for the sub-sections. The present study’s overall reliability coefficient was $\alpha = 0.92$, compared to the overall measure’s reliability value of $\alpha = 0.90$. Concerning each statement, a 5-point Likert-style answer scale was used.

A pilot study was conducted for the current investigation to recognize potential problems sooner and confirm the measure’s effectiveness.

Analysis and Findings

The tables below display the analytical results based on the participant data.

### Table 1: The Model Summary of Hierarchical Multiple Regressions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>F Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.932*</td>
<td>.889</td>
<td>.888</td>
<td>2.30436</td>
<td>.780</td>
<td>1468.796</td>
<td>1</td>
<td>114</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>.950*</td>
<td>.913</td>
<td>.912</td>
<td>2.91169</td>
<td>.055</td>
<td>125.951</td>
<td>1</td>
<td>113</td>
<td>.000</td>
</tr>
<tr>
<td>3</td>
<td>.961*</td>
<td>.925</td>
<td>.925</td>
<td>2.99800</td>
<td>.024</td>
<td>7.068</td>
<td>1</td>
<td>112</td>
<td>.002</td>
</tr>
</tbody>
</table>

Note: a. Predictors: (Constant), Readiness to Change
b. Predictors: (Constant), Readiness to Change, Innovative Work Behavior
c. Predictors: (Constant), Readiness to Change, Innovative Work Behavior, Technological Competence
d. Dependent Variable: Willingness to Employ Online Modalities

Source: Author’s fact-finding
Table 1 demonstrates the Model Summary of Hierarchical Multiple Regressions showing the differential joint influence of readiness to change, innovative work behavior, and technological competence on willingness to employ online modalities within South Africa’s universities.

Table 2: ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>14940.736</td>
<td>1</td>
<td>14940.736</td>
<td>1468.796</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>1738.421</td>
<td>115</td>
<td>4.723</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>16679.157</td>
<td>116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Regression</td>
<td>14597.411</td>
<td>2</td>
<td>6793.150</td>
<td>1896.405</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>1181.747</td>
<td>114</td>
<td>3.980</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>15779.158</td>
<td>116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Regression</td>
<td>14530.132</td>
<td>3</td>
<td>4102.637</td>
<td>1292.185</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>1159.025</td>
<td>113</td>
<td>3.889</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>15689.157</td>
<td>116</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: a. Dependent Variable: Willingness to Employ Online Modalities
b. Predictors: (Constant), Readiness to Change
c. Predictors: (Constant), Readiness to Change, Innovative Work Behavior
d. Predictors: (Constant), Readiness to Change, Innovative Work Behavior, Technological Competence

Source: Author’s fact-finding

Table 2 shows ANOVA table demonstrating the level of variances in willingness to employ online modalities within South Africa’s universities according to the independent measures (readiness to change, innovative work behavior, and technological competence).

Table 3: Summary of Hierarchical Multiple Regressions

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>100.963</td>
<td>.876</td>
</tr>
<tr>
<td></td>
<td>Readiness to Change</td>
<td>1.080</td>
<td>.063</td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>106.664</td>
<td>1.096</td>
</tr>
<tr>
<td></td>
<td>Readiness to Change</td>
<td>1.626</td>
<td>.051</td>
</tr>
<tr>
<td></td>
<td>Innovative Work Behavior</td>
<td>1.075</td>
<td>.025</td>
</tr>
<tr>
<td>3</td>
<td>(Constant)</td>
<td>102.364</td>
<td>1.792</td>
</tr>
<tr>
<td></td>
<td>Readiness to Change</td>
<td>.812</td>
<td>.057</td>
</tr>
<tr>
<td></td>
<td>Innovative Work Behavior</td>
<td>.717</td>
<td>.037</td>
</tr>
<tr>
<td></td>
<td>Technological Competence</td>
<td>1.134</td>
<td>.069</td>
</tr>
</tbody>
</table>

Note: – Dependent Variable: Willingness to Employ Online Modalities

Source: Author’s fact-finding

Table 3 reveals Summary of Hierarchical Multiple Regressions showing the differential independent and joint influence of readiness to change, innovative work behavior, and technological competence on willingness to employ online modalities within South Africa’s universities.

Table 3 showed that an independent variable (Readiness to change) was tested for its capacity to predict willingness to use online modalities using hierarchical multiple regression after the effects of innovative work behavior and technical proficiency were considered. It was also used to assess the ability of two independent factors (Readiness to change and innovative work behavior) to affect degrees of readiness to use online modalities after controlling for the impact of technological competence. The three independent characteristics (readiness to change, innovative work behavior, and technological competence) were also evaluated to determine the degree of desire to employ online modalities.

As was mentioned in the previous paragraph, all three independent variables significantly differed in their independent effects on willingness to use online modalities, with technological competence having a higher beta value ($\beta = .862$, $p < .001$) than readiness to change ($\beta = .771$, $p < .001$) and innovative work behavior ($\beta = .705$, $p < .001$). As a result, during the post-COVID-19 and 4IR periods, technological competency considerably and favorably influences the propensity to employ online modalities inside South Africa's institutions. The P-value is appropriate. This confirms that, throughout the post-COVID-19 and 4IR periods in South Africa, universities' adoption of online modalities is highly influenced by their technological proficiency. Additionally, the results...
demonstrate a significant positive relationship between readiness to change and employ online modalities in South Africa's institutions throughout the post-COVID-19 and 4IR periods. The p-value is appropriate. Consequently, the suggested theory is supported: Universities' willingness to change greatly impacts how they use online modalities in South Africa post-COVID-19 and 4IR. Additionally, the stated finding demonstrates that during the post-COVID-19 and 4IR periods, South Africa's institutions were considerably and favorably influenced by innovative work behavior. The value of p is suitable. According to the Post-Covid-19 and 4IR periods, it is accepted that innovative work behavior significantly impacts universities and that South Africa has adopted online modalities. Hence, the model in Figure 1:

![Diagram](image)

**Figure 1:** The independent and joint impacts of readiness to change, innovative work behavior, and technological competence on willingness to employ online modalities inside universities during the post-COVID-19 and 4IR.

**Discussion**

This study demonstrated that throughout the post-COVID-19 and 4IR periods, South Africa's institutions' propensity to adopt online modalities is considerably and favorably influenced by their readiness to change. This remark is based on the premise that South African universities will be much more inclined to use online modalities as their willingness to change increases. According to earlier empirical research (Ng’ambi et al., 2016; Mhlanga, 2022), universities with proactive policies and strategies for online learning were more likely to accept and successfully implement online modalities, and these findings are consistent with the position that during the COVID-19 pandemic, more change-ready South African universities were more successful in switching to online modalities. It also corroborates the findings of (Mncube et al., 2019)’s study on the institutional readiness for technology in South African universities. They noted that infrastructure, technological support, faculty development, and student support services affected the acceptance and implementation of e-learning at South African universities.

Similarly, this study has shown that creative workplace behaviors have a considerable and advantageous impact on universities' propensity to employ online modalities in South Africa during the post-COVID-19 and 4IR periods. The research findings suggest that South African universities are more likely to use online modalities post-COVID-19 and 4IR periods the more innovative work practices they demonstrate. These results support the notion by some researchers (for example, Marcolin & Guarino, 2020; De Jong et al., 2021) that individuals with more innovative work behavior were more likely to experiment and explore new technologies, which increased the use of e-learning modalities. That innovative work behavior positively influences the use of online modalities in universities throughout the post-COVID-19 and 4IR eras. Additionally, this finding supports the assertion made by some researchers (Anser et al., 2020) that implementing cutting-edge practices like project-based learning, blended learning, and flipped classrooms among academic staff. Instructional designers facilitated online modalities in South African universities during the Fourth Industrial Revolution (4IR) and post-COVID-19 era.

Furthermore, the research findings showed that, at South African universities during the Fourth Industrial Revolution (4IR) and post-COVID-19 era, technological competency considerably and favorably influenced willingness to employ online modalities. The
Conclusion drawn from this finding is that South African colleges will be increasingly eager to use online modalities as their technology proficiency increases. The current finding concurs with (Fernández-Batanero et al., 2021), who observed that technological advancement made hybrid learning methods—which combine online and in-person training—possible. Online and off-campus learning were seamlessly merged by universities with superior technology skills, providing students flexibility and personalized learning paths. These results support the assertion made by (La Harpe et al., 2021) that technology competence is necessary to successfully adopt online modalities in the context of South African universities. It facilitates creating and disseminating self-paced modules, adaptive learning systems, and customized content matched to each student's needs and preferences, enabling flexible learning schedules and individualized approaches.

The current findings showed that, during the post-Covid-19 and 4IR periods, when efforts were made to ascertain the differential independent and combined effects of readiness to change, innovative work behavior, and technological competence in South Africa's institutions, all three independent measures had a significant differential, independent impact on willingness to use online modalities. This suggests that, throughout the post-COVID-19 and 4IR periods, technology competency greatly influenced South Africa's institutions' propensity to employ online modalities over and above their readiness to change and innovative work behaviors. The third-step model of the current results shows that the three variables significantly impacted respondents' propensity to use online modalities more than alternative combination matrices. Therefore, during the post-COVID-19 and 4IR periods, 96.1% of South Africa's institutions were willing to use online modalities due to their readiness to change, innovative work behavior, and technological proficiency. The 3.9% difference in willingness to use online modalities in South Africa’s institutions between the post-COVID-19 and 4IR periods is the result of factors not considered in the current study. These findings support the hypothesis that in South Africa's universities during the post-COVID-19 and 4IR, technological competence, innovative work behavior, and readiness to change all have a significant and combined impact on assuring the adoption of online modalities.

In addition, this article creates a crucial paradigm that South African institutions can employ to increase and maintain the uptake of online modalities within South Africa's universities throughout the post-COVID-19 and 4IR periods (see Figure 2). Hence, Figure 2's layout.

**Figure 2:** A model to increase and sustain the adoption of online modalities within South Africa’s universities during the post-COVID-19 and 4IR periods; *Source:* Author’s results

**Applied implications**

In the current post-COVID-19 and 4IR phases, the study's findings will assist management in South African institutions in investing in a solid IT infrastructure and ensuring that all students have access to high-speed internet. Besides, it will help them create a well-organized and thorough plan that outlines the precise goals, objectives, and approaches for implementing online modalities in the current post-COVID-19 and 4IR eras (address the requirements and difficulties of various stakeholders, including faculty, staff, and students). Additionally, this study advises them on creating an environment that supports and promotes creativity. This includes praising and honoring inventive accomplishments.

In the post-COVID-19 and 4IR (Fourth Industrial Revolution) era, universities can capitalise on students' willingness to use online modalities, technological proficiency, inventive behaviour, and adaptability to improve the quality of education. They can use a hybrid learning strategy, which blends the finest aspects of online and traditional teaching techniques. With this method, students
can profit from face-to-face interactions and the adaptability and accessibility of virtual learning. Additionally, they can offer faculty members continuous professional development to improve their teaching and digital literacy. Training initiatives can support educators in utilising technology efficiently and adjusting to the ever-evolving nature of education. Furthermore, by fostering a culture that values experimentation and the discovery of innovative educational technology and approaches, the study’s findings will assist universities in encouraging their professors and staff to embrace innovation in teaching and learning. Finally, it will help universities develop a welcoming atmosphere that promotes adaptability.

**Contribution**

The clinical practice of motivating and sustaining an increased willingness to employ online modalities at South Africa’s universities during the post-COVID-19 and 4IR periods.

**Conclusion**

The results of this study show that, at South Africa’s universities during the post-COVID-19 and 4IR periods, technological competence, innovative work behavior, and readiness to change all have a substantial independent and combined impact on ensuring the adoption of online modalities.

However, it is imperative to consider the following suggestions:

i. Management in South African institutions should invest in a robust IT infrastructure and guarantee that all students have access to high-speed internet in the present post-COVID-19 and 4IR periods. Faculty, staff, and students should all have access to comprehensive technological training programs. Besides, they must continuously lead conferences, workshops, and seminars to motivate professors to use technology in their classrooms. They need to examine and update current policies and regulations to consider the evolving nature of online education and technical improvements.

ii. Management in South African universities should develop a well-structured and comprehensive plan that outlines the specific goals, objectives, and strategies for implementing online modalities in the current post-COVID-19 and 4IR eras (address the needs and challenges of various stakeholders, including faculty, staff, and students). They should also ensure the university has the hardware and software required to facilitate online education. In addition, they must establish specialized support systems, including helpdesks and online support portals, to aid staff, instructors, and students with technological problems and difficulties associated with online modalities. Additionally, before implementing online modalities on a large scale, university administration in South Africa should do small-scale pilot programs to test and improve them.

iii. To inspire people to use online modalities in the post-COVID-19 and 4IR eras, management in South African institutions should foster an environment that values and encourages innovation. This includes recognizing and rewarding innovative achievements. Besides, colleges should create designated areas or innovation centers where teachers, staff, and students can get together to develop and test out new ideas. Further, they must set aside funds and resources to support 4IR and online modalities-focused research and development initiatives. Additionally, they could establish alliances with companies and organizations to promote knowledge transfer, internships, and team projects. In addition, university administration in South Africa might create incubators and accelerators there to foster and assist innovative start-ups and business initiatives.

Future studies should study the problem using a mixed-methods approach to understand better the factors that influence the use of online modalities during the post-COVID-19 and 4IR periods.

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**References**


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