administrative sciences

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Predictors of Digital Competence of Public University Employees and the Impact on Innovative Work Behavior

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Abstract: Digital competence plays an important role in higher education. The literature highlights the adoption and use of digital competence for the development of educational services in Higher Education Institutions (HEIs), but it is still necessary to understand its influence on the innovative behavior of the public official. This study aims to investigate the influence of digital competence, based on the predictors' infrastructure, integration, and digital management, on innovative work behaviors. The research was applied to 540 public employees of a Federal Institution of Higher Education (IFES) in northern Brazil. The response rate for this study was 33.5%. The Structural Equation Modeling approach by Partial Least Squares (PLS-SEM) was used. Empirical findings confirm that public employees with a high level of perception of digital competence more often develop challenging work to generate new innovative behaviors at work. This research was limited to investigating the influence of digital competence on innovative work behaviors of public employees of a Brazilian IFES. Future studies may address other contextual factors in this relationship. One of the practical implications is the need for managers in the education sector to support the construction of guidelines for educational and technological innovation to expand innovative behavior at work.

Keywords: digital competence; innovative work behavior; education innovative; public administration

Citation: Carvalho, Larissa Pinon de, Thiago Poleto, Camila Carvalho Ramos, Fernando de Assis Rodrigues, Victor Diogho Heuer de Carvalho, and Thyago Celso Cavalcante Nepomuceno. 2023. Predictors of Digital Competence of Public University Employees and the Impact on Innovative Work Behavior. *Administrative Sciences* 13: 131. https://doi.org/10.3390/admsci13050131

Received: 1 March 2023
Revised: 25 April 2023
Accepted: 26 April 2023
Published: 11 May 2023

1. Introduction

Brazilian Higher Education Institutions (HEIs) are challenged to develop innovative educational solutions to meet the requirements of developing new competencies. In this sense, digital technologies contribute to transforming the way public educational services add value to the formation of a new profile of university students (Hashim et al. 2022). The commercial value of digitization does not only involve the integration of new digital technologies into today's infrastructure but also represents how these new technologies can be used to transform business processes and create business value (Castioni et al. 2021). Higher Education Institutions discuss the implementation of concepts such as big data, data vigilance, and artificial intelligence associated with Industry 5.0 (Baig et al. 2020).

In the educational sphere, a large volume of data is produced through online courses and teaching and learning activities. An important factor in educational practices is considered the influence of digitization, algorithm-based media, and machine learning as they create new improvements in and explore the relationships between process digitalization and learning practices, which modify the way people access information and communicate and coordinate services (Van de Wetering et al. 2021; Verhoef et al. 2021). The information and services quality and the complexity of the used systems are also highlighted factors in the digitization process, supporting the automation of academic life (Dospinescu and

Dospinescu 2020). The digitization of academic life implies finding the surplus of the teaching-learning process with digital tools andincreasing the motivation for concrete, effective, and subject-oriented examples, all guided by experienced professionals, such as teachers (Amhag et al. 2019).

Digital technologies integrated with artificial intelligence are necessary to advance flexible educational practices. In recent years, digital technologies have been important during the COVID-19 pandemic, and thoughts about the impact of the pandemic have brought about new learning (Galanti et al. 2023; Hoti et al. 2022). Digital technologies have provided public employees with academic support tasks at home, supported by IT infrastructure resources, process digitization, and management monitoring (Nikou and Aavakare 2021). From this, it is appropriate to prepare managers, teachers, and students for future uncertainties by assuming digital competences; this, in turn, refers to access, knowledge, pro-activity, and mastery of digital technologies with progressive levels of autonomy and learning (Ala-mutka 2011). In this digital context, several factors are known to affect digital teaching competence; these are macro-environmental factors, where the state interferes in technological progress with policies for the development of digital competence for the population; environmental factors, where the university includes digital tools in education to ensure the professional development of teachers through the availability and quality of digital resources; micro-environmental factors, referring to support in the development of digital competence; and personal factors, where the individual feels motivated to aid in the development of digital competence (Pesha 2022).

Digital competence has recently gained a strong prominence in the educational context, being one of the key competencies that citizens in general, and teachers specifically, should master in the society of the future (Cabero-Almenara et al. 2020; Tejada Fernández and Pozos Pérez 2018). On the one hand, the use of technology has become an everyday occurrence due to advances in the creation and exchange of content on the internet and social networks. On the other hand, the development of many individuals depends, for the most part, on adequate and efficient use of ICTs (Basilotta-Gómez-Pablos et al. 2022). The literature addresses several frameworks that determine teachers' digital competence levels. In the European context, the DigCompEdu (Digital Competence Framework for Educators) framework was developed based on six areas of digital competence teachers must have to promote effective, inclusive, and innovative learning strategies using digital tools (Caena and Redecker 2019).

Other previous studies propose frameworks for assessing the digital competence of university teachers and staff (Ciriza-Mendívil et al. 2022; Dias-Trindade and Ferreira 2020; Nikou and Aavakare 2021), analyzing the level of digital competence of teachers in higher education (Guillén-Gámez and Mayorga-Fernández 2020), identifying the factors that influence the development of competence in teachers (Basantes-Andrade et al. 2020; Cabero-Almenara et al. 2020), and stimulating the development of digital teaching competence (Fadli et al. 2020; Gleason and Manca 2020). Finally, they examine the positive impact of digital competence on organizational agility and performance (Ravichandran 2018; Yu and Moon 2021).

Innovation at work is occurring rapidly in sectors such as the automotive industry and startups. However, the innovation transition is slower in some sectors, including education. In the future, formal educational institutions will likely continue to disseminate relevant knowledge to society. However, if those educational institutions take a long time to adapt, the market tends to replace parts of the formal education models with an alternative and more dynamic model. It is important to note that digital competence does not replace all conventional literacy skills. Indeed, these skills are still critical to success in everyday life and citizen education. However, digital competence offers a valuable extension of these skills, allowing those involved in the transformation process to be part of more cohesive work groups, to access information more quickly, and to share it efficiently, regardless of physical location.

In public education, innovative behavior involves workgroup abilities and collaboration with educators and public servants to develop creative solutions to educational problems and challenges. However, it is paramount to emphasize that innovative behavior is not just the responsibility of educators. Educational institutions are part of the process and must encourage and support innovation by providing resources and tools for educators who want to experiment with new teaching approaches. In addition, educational institutions must create an environment that encourages innovative behavior, valuing creativity and critical thinking. The insights provided by the new technological and educational innovation paradigm could be used by individuals with skills that will demand to build a theoretical model of the hypothetical relationship between digital competence and the IWB of civil servants in the future. As individuals affiliated with educational organizations and using digital resources, employee IWBs are inevitably affected by digital competence.

The main objective of this study is to investigate the influence of practices on digital competence on the behavior of innovative work. We approach this objective with the following question: How does digital competence influence innovative behavior in the work of civil servants in a Higher Education Institution?

Among the goals derived from the main objective, we can list the understanding of innovative behavior at work and the analysis of the impact of digital competence on innovative behavior at work. Following this logic and considering that previous studies do not relate digital competence to innovative behavior at work, this study extends the existing literature on innovative work behavior. Therefore, it can be considered opportune and appropriate to understand individual innovation. The relevance of this research is to contribute to the study of individual differences as a predictor of behaviors that implies innovative behavior at work, which may apply to management practices and policies, especially with the proposition of new innovative educational management models focusing on developing effective assessment strategies, including advanced assessment technologies to provide instant feedback, such as the application of artificial intelligence. Another innovative practice is adopting competency-based learning models, which accentuate developing specific skills and competencies rather than simply memorizing facts. This context requires a more personalized approach to education.

To investigate the relationship proposed in this article, we conducted an empirical study with 181 civil servants, who have experience with Business Process Management (BPM) and digitalization of processes, through the application of online questionnaires between October and November 2022; these civil servants were all employed at a Public Institution of Higher Education in Northern Brazil. For data analysis, the Partial Least Squares Structural Equation Modeling Technique (PLS-SEM) was applied using the SmartPLS 4 software package.

The remainder of this article is divided as follows: Section 2 provides the background based on the literature and also defines the hypotheses to be tested; Section 3 presents the obtained results; Section 4 presents the description of the methodological procedures applied in the research; Section 5 makes the necessary comments and brings the theoretical and practical implications of the research and also presents the limitations of the research and indicates directions for future developments. Finally, Section 6 contains the article's conclusions.

2. Literature Background and Hypotheses

Digital competence has recently been a factor of success and organizational competitiveness (Pesha 2022). This competence contains three central factors: digital infrastructure, digital integration, and digital management (Yu and Moon 2021). Digital infrastructure refers to the organization's use of digital-related architecture to adapt organizational processes, specifying structures and responsibilities that meet technological changes. Digital integration refers to the ability to integrate strategies aligned with digital technologies. Digital management relates to the management of digital-related competencies and experi-

ences by the organization, to meet the requirements of infrastructure support, and digital training of employees (Kindermann et al. 2021; Yu and Moon 2021).

Innovative Work Behavior (IWB) refers to the employee's behavior aimed at generating, introducing, and/or applying (within a function, group, or organization) new ideas, processes, products, or procedures intended to benefit the unit of work (De Spiegelaere et al. 2014). The concept implies that individuals manage, promote, and realize innovative ideas for improvements in, for example, products or processes. The IWB refers to the exploration, generation, defense, and implementation of ideas (De Jong and Den Hartog 2010). Prior research supports innovative work behavior. First, for young start-ups, authentic leadership has a significant effect on innovative work behavior among indian employees (Sengupta et al. 2023). Second, challenge stressors improve innovative work behavior (Yu et al. 2023). In this context, new scales for innovative work behavior (IWB) were presented for the success of educational institutions (Ayoub et al. 2023).

2.1. Digital Competence: Digital Infrastructure and Innovative Work Behavior

New educational contexts require digital technologies, such as video conferencing platforms, cloud file storage platforms, messaging applications, and management information systems. They allow employees to spend most of their time connected, which is an opportunity for educational improvement and innovation as technologies involve changes in educational practices and processes (Ciriza-Mendívil et al. 2022; Rivero and Mur 2015). First, digital technologies provide massive access to data, information, and resources. Employees can search for information, learn new competences, and learn new technologies and trends much more easily than before. This can drive creativity and innovation, as employees have more access to information and resources to help them create new ideas and ways to improve work processes.

Second, they facilitate communication and collaboration because they allow employees to connect and share information easily, regardless of geographic distance (Hoti et al. 2022; Li et al. 2009), which can induce innovative ideas. Third, they promote flexibility and mobility to employees, allowing them to work from anywhere and at any time (Sengupta and Al-Khalifa 2022). This may create a more innovation-friendly environment as employees may have more time and space to think and explore new ideas. Finally, digital infrastructure could also increase the efficiency of work processes (Saeed 2019), providing more time for innovation. For example, automation tools could help to eliminate repetitive tasks and allow employees to focus on more creative activities to stimulate innovative behavior at work.

Authors have pointed out that an organizational climate favorable to innovation influences innovative employee behaviors (Afsar and Umrani 2020). Similarly, confidence in innovation influences a high level of innovative work behavior. Confidence facilitates the desire among employees to contribute new insights, as it results in an open-minded atmosphere in which employees feel confident in bringing suggestions and contributions to the discussion (Afsar et al. 2015). In addition, studies indicate that a supportive environment, both of management and the work team, arouses individuals' interest in proposing innovative ideas, which consequently impacts positively and directly on innovative work behavior (Attiq et al. 2017). In addition, individuals with motivation to learn and learner guidance tend to see new and difficult tasks, such as IWB, as both challenging and as opportunities to learn (Afsar and Umrani 2020; Atitumpong and Badir 2018).

Employees will not be replaced, but technology is available to add to their work in order to establish new ways to integrate these technologies into their processes (Antonucci et al. 2021). Its functions will be performed more effectively, without wasting hours finding information or occupying itself with paper stacks. Faced with this scenario, technology provides more assertive demands, greater flexibility, and access to information; this changes employees' work behavior because it allows them to be resilient, adaptive, and directed to collective alignment. Moreover, one of the reasons technology has advanced in recent decades is that digital transformation has expanded the human capacity to reflect on routine

issues and challenges and find creative and innovative solutions. Therefore, it is interesting to test to what extent digital infrastructure can stimulate innovative work behavior. On this basis, hypothesis 1 (H1) is suggested:

Hypothesis 1. *Digital infrastructure is positively related to Innovative Work Behavior.*

2.2. Digital Competence: Digital Integration and Innovative Work Behavior

Digital technologies have an important role to play in public educational institutions (Hashim et al. 2022). They can be used to increase the quality of teaching and learning through the use of distance learning tools, learning platforms, and class management, as well as making the management and administration of institutions more efficient. This is achieved through the use of management information systems, which enable the integration of data between various sectors, to allow the sharing and free use of information from other units in real-time, which can help employees get to know the team, understand team processes, and have a broader view of the work being done, and to contribute to more efficient teamwork, impacting on the speed of procedural flows, meaning that less time is required to complete a task (Ciriza-Mendívil et al. 2022; Hoti et al. 2022).

To integrate digital technologies into organizations, it is necessary to refit and change the work processes, to facilitate new processes with new proposals of managerial and organizational alignment, and to use new ways of integrating people (Antonucci et al. 2021; Kindermann et al. 2021; Quinton et al. 2018). For this, it is essential that the institution's strategic planning includes an effective digital strategy (Bharadwaj et al. 2013). This requires adequate infrastructure, employee training, clear and well-defined usage policies, and adequate investments (Sengupta and Al-Khalifa 2022).

In this sense, digital technology could be critical to organizations in supporting creative and innovative processes. It allows employees easy access to information and collaboration, which may lead them to be more innovative and explore new possibilities (Antonucci et al. 2021; Austin et al. 2012). This is especially useful when employees request to gather information from various sources in order to make decisions or resolve issues quickly, or when they need to exchange information with others quickly and efficiently. In this way, organizations must find ways to innovate through technologies, developing digital strategies that drive innovative behaviors (Hess et al. 2016).

Self-esteem, self-efficacy, and autonomy at work could be factors that influence the development of innovative behaviors at work (Atitumpong and Badir 2018; Attiq et al. 2017; Bos-Nehles and Veenendaal 2019). In addition, job crafting, a process by which employees act as active agents, shaping and redesigning their work processes to ensure a good person-to-work fit in their work environment, facilitates the process of creating changes, thereby inducing innovative behaviors (Afsar et al. 2019).

In a scenario where technology is present full-time in organizations, it is necessary to understand the interactive potential of the electronic tools used day-to-day and to obtain the ability to use virtual resources that allow the extraction of information, intelligent connections and communication with different sectors of the organization; this induces employees to reflect on innovative solutions to improve the digital integration of organization. Therefore, this research investigates whether digital integration in organizations has a positive impact on innovative behavior at work. On this basis, hypothesis 2 (H2) is presented:

Hypothesis 2. *Digital integration is positively related to Innovative Work Behavior.*

2.3. Digital Competence: Digital Management and Innovative Work Behavior

Due to the intensifying demand for digital competence in the labor market, employers are interested in developing the digital competence of future experts as part of their training at university (Pesha 2022). Therefore, the development of teachers' digital competence is a relevant issue, since the construction of students' ability to live in a digital environment

depends, to a large extent, on their digital literacy. The use of digital technologies in the implementation of curricula increases the level of assimilation of course material by students and helps in the formation of digital competence of future specialists (Attali and Arieli-attali 2015). Thus, it is appropriate that educational institutions develop digital competence, both among students and between teachers and university technicians, to increase efficiency in teaching-learning and administrative processes. To do this, institutions must conduct consistent digital management through conducting training to develop digital knowledge and competence (Galanti et al. 2023).

In this context, the ability to manage and analyze information, as well as communication competence, learning autonomy, and critical thinking, have become common characteristics of professionals in the digitalized information age, which induces individuals to creativity in the elaboration of strategies and problem-solving in an environment of digital solutions. The digital scenario encourages employees to develop new competence and expand existing expertise in order to obtain the ability to constantly resignify and adapt to the evolution of the modern world, inducing them into behaviors focused on innovation (Galanti et al. 2023).

When managing digital knowledge, managers should adopt a transformational leadership style that inspires employees individually by developing a strong sense of shared vision and belonging to the organization; this can encourage employees to engage in innovative work behaviors (Afsar and Umrani 2020; Afsar et al. 2014; Afsar et al. 2019; Maria Stock et al. 2017). In addition, the sharing of digital knowledge nourishes employees with enough information to generate and implement new ideas, and to provide innovative work behaviors (Afsar et al. 2019; Bos-Nehles and Veenendaal 2019). Furthermore, HR practices, such as digital-focused training and development, rewards for employees who stand out in the digital industry, and feedback related to digital practices, can positively influence innovative behaviors at work (Afsar et al. 2019; Bos-Nehles et al. 2017).

By investing in the development of knowledge and competence necessary to leverage the use of technology, organizations improve the digital experience of employees and, as a result, increase the innovation capacity and creativity of employees, making them want to engage, increasingly, in the evolution of the organization through innovative ideas and solutions. For this reason, this research examines the influence of digital management on innovative work behaviors. On this basis, hypothesis 3 (H3) is presented:

Hypothesis 3. *Digital management is positively related to Innovative Work Behavior.*

Figure 1 describes the central conceptual research model of this study in order to present the relationship between digital competence and innovative behavior at work. First, the relationship between digital infrastructure and innovative behavior at work was explored. Second, the relationship between digital integration and innovative behavior at work was evaluated. Finally, the relationship between digital management and innovative behavior at work was evaluated.

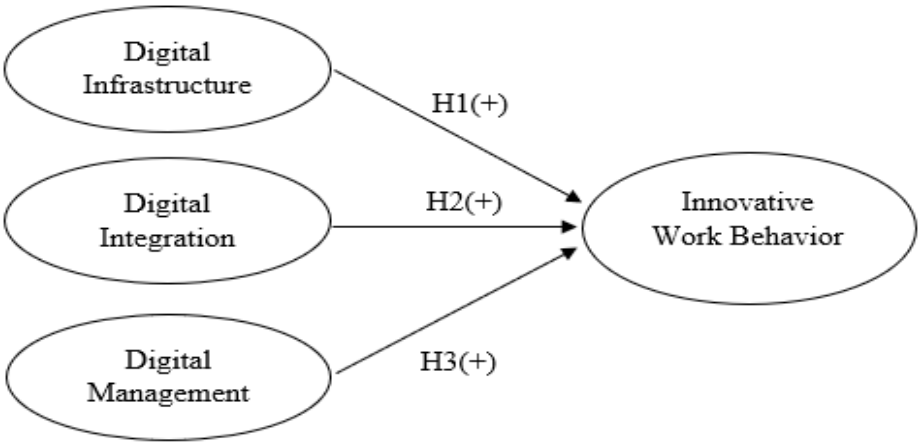

Figure 1. Research Model Digital Competence and Innovative Work Behavior.

2.4. The Negative Effects of Digital Competence over Innovative Work Behavior

Despite the positive impacts of the digital competence elements (infrastructure, integration, and management) on innovative work behavior, there are also elements that act in an inverse way, causing negative impacts; these include physical and mental discomfort and stress, digital distractions, motivation for long periods of activity, learning difficulties, etc. In terms of discomfort, this may be related to receiving direct instructions to perform the work in the traditional (presential) way (Darazha et al. 2021), causing, for instance, anxiety (Gansser and Schultz 2020). Burnout syndrome, for instance, is a potentially negative effect, causing a combination of symptoms including physical, emotional, and social stress, thereby decreasing work performance (Ramos et al. 2023).

Digital distraction is another problem that can emerge when developing people's digital competences, since in the cyber world several distractive elements can absorb the workers' attention and even cause work interruptions and a decrease in productivity (Gerbaulet and Korn 2018). Despite being a tool in the digital transformation, integration, and communication, social media can also be a harm for the worker's attention, directly affecting his performance in developing work-related tasks, as it is easy to shift from the digital working area into digital social networks and other related channels (Andersson et al. 2021).

Motivational barriers can also appear in the three hypothesis relations of interest, especially from a psychological perspective, since the users may not feel able to use the digital tools. This can occur as a result of their socioeconomic level or personal learning difficulties, which may make it difficult to absorb the necessary experience needed to use these tools productively (Dobson et al. 2022). There is another perspective for these difficulties in adopting digital work and competences; cognitive difficulties, related to neurological disorders, can disable workers. These include Parkinson's disease, different types of sclerosis, or even people who have suffered strokes and are undergoing rehabilitation processes (Lindberg et al. 2021).

Independent of the case, each potential cause of negative effects in the relations of digital transformation should be considered in the counter hypothesis to those previously de-fined, if not by direct testing, then at least by the effects it presents.

3. Results

3.1. Measurement Model Test

The objective of the Measurement Model is to evaluate the quality of measurement of latent variables that were used to test the hypotheses established for this research. Thus, reliability, convergent validity, and discriminant validity of each construct were evaluated.

Figure 2 shows the Measurement Model test. This test shows the factor loadings for each item, which range from 0.608 to 0.852. In addition, it presents Cronbach's Alpha for each construct, ranging from 0.703 to 0.788, and structural coefficients from 0.208 to 0.394.

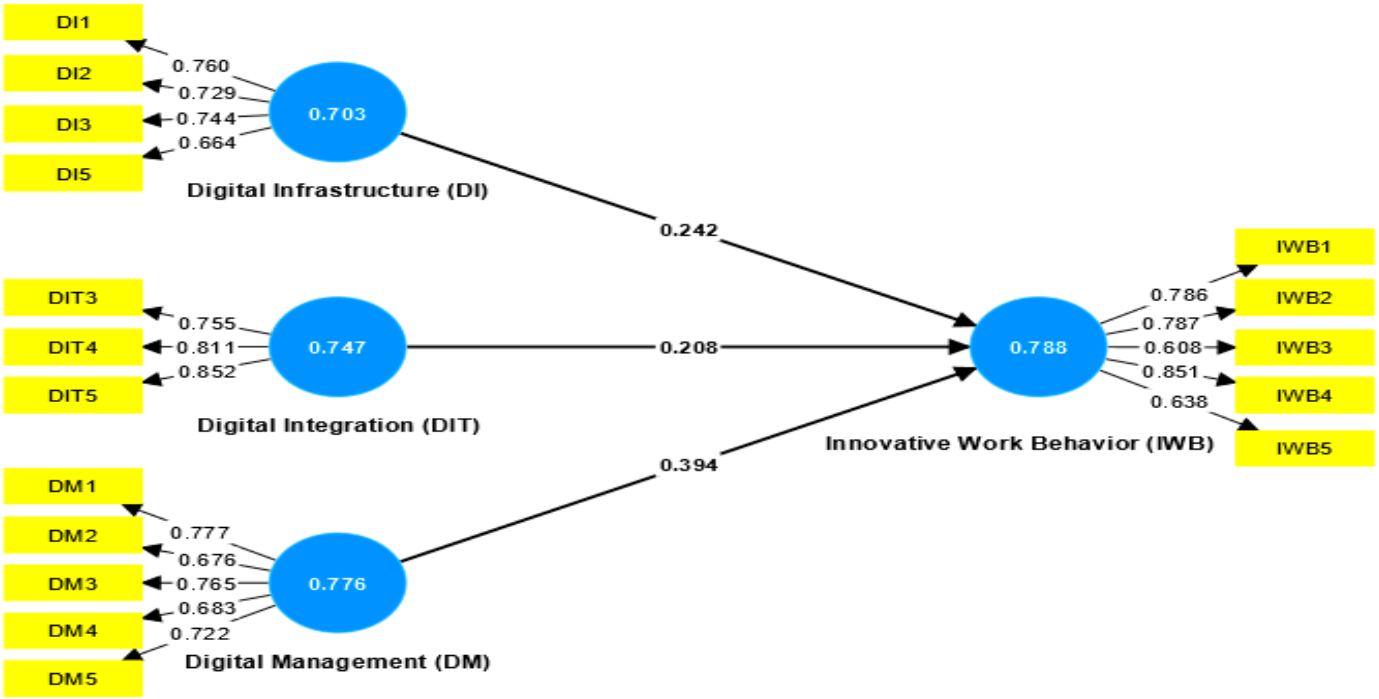

Figure 2. Measurement Model Test.

In terms of convergent validity, the AVE (Average Variance Extracted) score of each construct must exceed 0.50 (Fornell and Larcker 1981). According to Table 1, the AVE scores of all constructs were >0.5, providing sufficient evidence of convergent validity after discarding the item "DI4" of the Digital Infrastructure (DI) construct and the items "DIT1" and "DIT2" of the Digital Integration (DIT) construct; this is because their low factor loadings (<0.40) were decreasing the AVEs of these constructs (Fornell and Larcker 1981; Henseler et al. 2009; Ringle et al. 2014).

Table 1. Loads, Cronbach's Alpha, composite reliability and AVE.

Construct	Items	Loads	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE
Digital Infrastructure (DI)	DI1 DI2 DI3 DI5	0.760 0.729 0.744 0.664	0.703	0.703	0.816	0.526
Digital Integration (DIT)	DIT3 DIT4 DIT5	0.755 0.811 0.852	0.747	0.810	0.848	0.651
Digital Management (DM)	DM1 DM2 DM3 DM4 DM5	0.777 0.676 0.765 0.683 0.722	0.776	0.784	0.847	0.527
Innovative Work Behavior (IWB)	IWB1 IWB2 IWB3 IWB4 IWB5	0.786 0.787 0.608 0.851 0.638	0.788	0.802	0.856	0.548

In terms of reliability (internal consistency), Cronbach's α and composite reliability (CR) values should exceed 0.7 (Hair et al. 2017). According to Table 1, all Cronbach's α values and composite reliability (CR) were >0.7, suggesting good internal consistency. In terms of indicator reliability, the factorial loading of each indicator must be greater than 0.7. Commonly, the indicators with loadings between 0.40 and 0.70 should only be removed from the scale if their exclusion leads to an increase in the composite reliability above the value suggested limit (>0.7) (Hair et al. 2017). According to Table 1, more than 75% of the indicator loads were > 0.7, but 4 loads (DI5 = 0.664; DM2 = 0.676; DM4 = 0.683; IWB5 = 0.638) are in the range between 0.4 and 0.7. When examining the composite reliability of all constructs, without excluding the factor loadings >0.4 and <0.7, it appears that the CRs already had a value > 0.7. By excluding them, it was found that the composite reliability remained with a load greater than 0.7, so the exclusion of items was not necessary, suggesting good reliability (Hair et al. 2017).

Three criteria were analyzed for discriminant validity: (1) Fornell–Larcker; (2) Cross-loading and (3) HTMT (The Heterotrait-monotrait ratio). Fornell–Larcker describes that a latent construct shares more variance with its assigned indicators when compared to another latent variable in the structural model. The AVE of each latent construct should be greater than the highest square correlation of the latent construct with any other latent construct (Fornell and Larcker 1981; Hair et al. 2017). Table 2 presents the results and indicates the fulfillment of the assumptions of the Fornell–Larcker. Cross-loading compares the loading of an item on its related construct with its cross-loading on other constructs (Liu et al. 2018). According to Table 3, the external loadings of the indicators of the constructs themselves were all higher when compared to the cross-loadings. The Heterotrait-monotrait ratio (HTMT) is the mean of all correlations of indicators across constructs measuring different constructs (the heterotrait-heteromethod correlations) relative to the geometric mean of the average correlations of indicators measuring the same construct (the monotrait-heteromethod correlations). O HTMT must be less than 0.90 (Henseler et al. 2015). As shown in Table 4, all correlations comply with the criterion. Therefore, according to the Fornell–Larcker criterion, Cross-loading, and the Heterotrait-monotrait ratio, all constructs have good discriminant validity.

Table 2. Discriminated validity test (Fornell–Larcker criterion).

	DI	DIT	DM	IWB
DI	0.725			
DIT	0.389	0.807		
DM	0.574	0.509	0.726	
IWB	0.549	0.503	0.639	0.740

DI = Digital Infrastructure; DIT = Digital Integration; DM = Digital Management; IWB = Innovative Work Behavior.

Table 3. Discriminated validity test (Cross loadings).

	Digital Infrastructure	Digital Integration	Digital Management	Innovative Work Behavior
DI1	0.760	0.368	0.427	0.460
DI2	0.729	0.104	0.345	0.287
DI3	0.744	0.317	0.345	0.380
DI5	0.664	0.277	0.515	0.420
DIT3	0.207	0.755	0.341	0.309
DIT4	0.270	0.811	0.319	0.318
DIT5	0.410	0.852	0.515	0.524
DM1	0.433	0.401	0.777	0.553
DM2	0.371	0.331	0.676	0.371
DM3	0.484	0.359	0.765	0.439
DM4	0.424	0.361	0.683	0.498
DM5	0.361	0.387	0.722	0.419

Table 3. *Cont.*

	Digital Infrastructure	Digital Integration	Digital Management	Innovative Work Behavior
IWB1	0.369	0.378	0.451	0.786
IWB2	0.508	0.388	0.483	0.787
IWB3	0.263	0.267	0.343	0.608
IWB4	0.447	0.442	0.499	0.851
IWB5	0.396	0.355	0.549	0.638

DI = Digital Infrastructure; DIT = Digital Integration; DM = Digital Management; IWB = Innovative Work Behavior.

Table 4. Discriminated validity test (Heterotrait-monotrait ratio—HTMT).

	Digital Infrastructure	Digital Integration	Digital Management	Innovative Work Behavior
Digital Infrastructure			0.755	0.702
Digital Integration	0.470		0.630	0.607
Digital Management				0.795
Innovative Work Behavior				

The model was tested to ensure that collinearity was not a problem; to ensure this, variance inflation factors (VIFs) must be less than 3.3 (Kock 2015). As shown in Table 5, all constructs had VIF below the conservative threshold of 3.3, with a minimum value of 1.375 and a maximum value of 1.740, thus suggesting that multicollinearity was not a critical problem in the investigation.

Table 5. Colinearity statistics (VIF)—Inner model.

Path	VIF
Digital Infrastructure -> Innovative Work Behavior	1.520
Digital Integration -> Innovative Work Behavior	1.375
Digital Management -> Innovative Work Behavior	1.740

3.2. Structural Model Test

The next step was to evaluate the results of the structural model and test the proposed hypotheses. The quality of the structural model was evaluated using two indicators. The first indicator evaluates the explanatory power of the model through the value of R^2, R^2, and the value of the explanatory effect f^2. The second indicator evaluates the predictive ability of the model by analyzing the significance of the path coefficients, the predictive correlation Q^2, and the value of the effect q^2.

R^2 reflects the proportion of variation endogenous constructs that can be explained by the exogenous constructs in the model (Hair et al. 2017). According to Table 6, the three exogenous constructs together (DI, DIT e DM) explain 48.9% of the variance of the endogenous construct IWB (R^2 = 0.489; R^2 adjusted = 0.481), which shows a moderate explanatory power (Hair et al. 2017). The value of the explanatory effect f^2 measures the amount of change in value R^2 after excluding the specific exogenous variables in the model (Hair et al. 2017).

The analysis of the statistical significance of the path coefficients was calculated using the bootstrap with five thousand samples for a one-tailed test with a significance level of 0.05 (Hair et al. 2017). For the choice of five thousand bootstrap samples, an evaluation was performed. First, a smaller number of bootstrap sub-samples were chosen (for example, 1000) to be drawn randomly and estimated with the PLS-SEM algorithm because of the shorter processing time. Subsequently, the preparation of the final results was changed to a large number of subsamples bootstrap (for example, 10,000). Thus, the modification aims to ensure the stability of the results. Understanding that five thousand samples are sufficient for the research, the same samples were applied. Furthermore, the one-tailed

test was chosen as positive assumptions were made in the research hypotheses (Kock 2015). According to the value assessment criterion f^2 of Cohen, as seen in Table 6, all exogenous variables have significant explanatory power in the model. The explanatory power of the exogenous variable "DM" is considered higher (f^2 = 0.175—average effect) when compared to the explanatory power of the exogenous variables "DI" and "DIT" (f^2 = 0.076 and f^2 = 0.062—small effect) (Cohen 1988).

Table 6. Model's explanatory capacity (R^2, R^2 adjusted, f^2).

Endogenous Latent Variable	R^2	R^2 Adjusted	Effect Size f^2
Innovative Work Behavior (IWB)	0.489	0.481	
Path			
Digital Infrastructure (DI) -> Innovative Work Behavior (IWB)			0.076
Digital Integration (DIT) -> Innovative Work Behavior (IWB)			0.062
Digital Management (DM) -> Innovative Work Behavior (IWB)			0.175

Through the bootstrap procedure, we identified that the path coefficients DI -> IWB, DIT -> IWB, and DM -> IWB are significant ($p < 0.01$), as shown in Figure 3. In addition, a predictive correlation was analyzed (Q^2 of Stone–Geisser) that represents an evaluation criterion for the predictive relevance of cross-validity of the path model PLS and aims to evaluate the accuracy of the fitted model and should be not equal to null (Hair et al. 2017). According to Table 7, Q^2 has a value of 0.451, indicating that the exogenous constructs have predictive relevance for the endogenous construct under consideration. In addition, the relative impact of predictive relevance was compared by measuring the effect size q^2, which allows us to evaluate the contribution of an exogenous construct to the value Q^2 of an endogenous latent variable. According to Table 7, it can be seen that the exogenous construct "DM" has greater predictive relevance (q^2 = 0.162—average effect), when compared to the predictive relevance of "DI" "DIT" (q^2 = 0.055 e q^2 = 0.038—small effect).

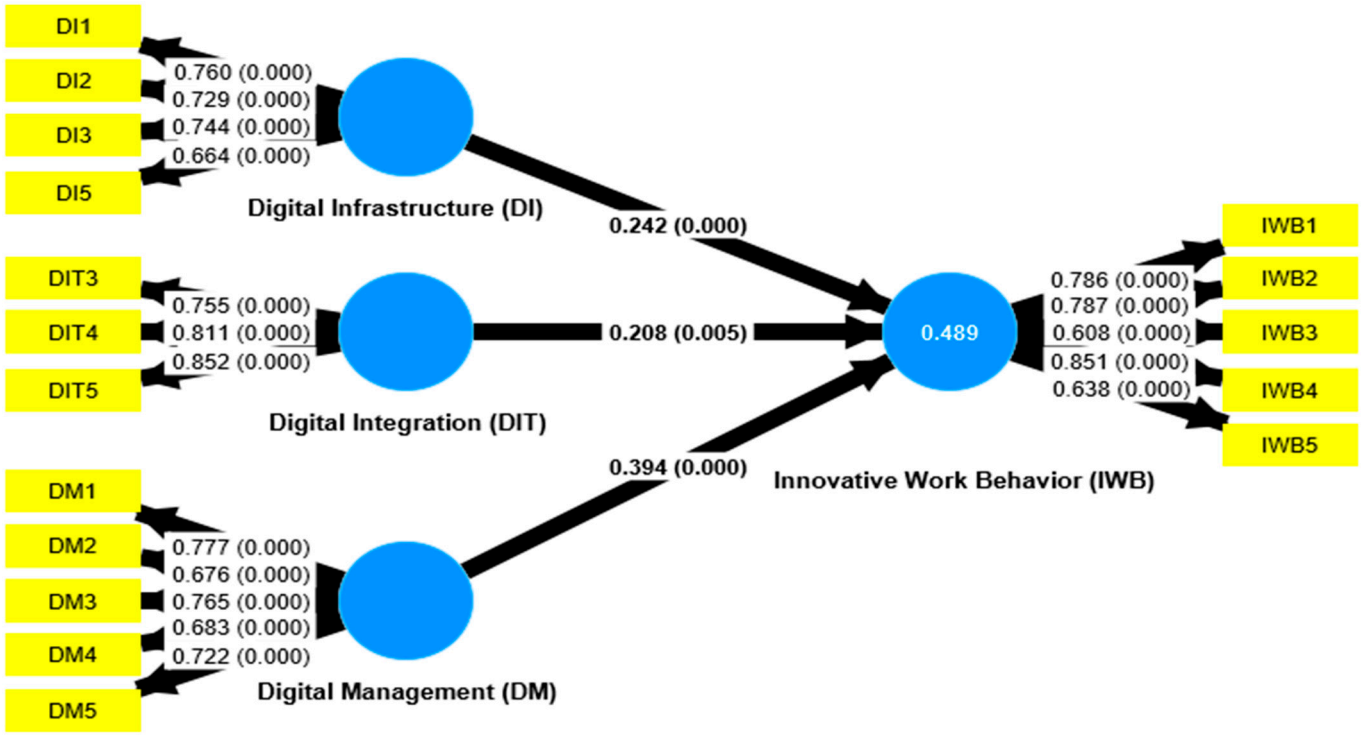

Figure 3. Structural Model Test.

Table 7. Model's Predictive Capacity (Q^2 and effect size q^2).

Constructs	Q^2	Q^2 Excluded	Effect Size q^2
Innovative Work Behavior (IWB)	0.451		
Digital Infrastructure (DI)		0.421	0.055
Digital Integration (DIT)		0.430	0.038
Digital Management (DM)		0.362	0.162

According to Figure 3 and Table 8, the structural model confirms the positive associations between DI and IWB (β = 0.242, $p < 0.001$), DIT and IWB (β = 0.208, $p < 0.01$), and between DM and IWB (β = 0.394, $p < 0.001$). Therefore, the path coefficients referring to the three presented hypotheses are significant. Thus, structural model supports all the hypotheses H1, H2, and H3. The exogenous construct DM exerts a stronger effect on the endogenous construct IWB, followed by DI and DIT, respectively. Also, according to the T statistics, the intensity of the DM and IWB relationship is more prominent (Hair et al. 2017; Nascimento and Macedo 2016).

Table 8. Hypothesis testing results.

Hypothesis	Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	p Values	Result
H1 (+)	DI -> IWB	0.242	0.247	0.064	3.782	0.000	Supported
H2 (+)	DIT -> IWB	0.208	0.209	0.081	2.574	0.005	Supported
H3 (+)	DM -> IWB	0.394	0.397	0.076	5.189	0.000	Supported

Furthermore, a 5-point Likert scale was used to understand the behavior of the constructs through the descriptive statistics of the questions that compose them. According to Table 9, the average, median, minimum, maximum, and standard deviation of each question are verified. Regarding the Digital Infrastructure (DI) construct, all questions (DI1, DI2, DI3, and DI5) are close to scale 4. Regarding the Digital Integration construct (DIT), one question (DIT3) is close to scale 4, and two questions (DIT4 and DIT5) are close to scale 3. Regarding the construct of Digital Management (DM), all questions (DM1, DM2, DM3, DM4, and DM5) are close to scale 4. Finally, in the construct Innovative Work Behavior (IWB), all questions (IWB1, IWB2, IWB3, IWB4, and IWB5) are close to scale 4. Additionally, when analyzing Table 10, it is possible to observe that the four constructs (Digital Infrastructure, Digital Integration, Digital Management, and Behavior of Innovative Work) had an average of around 4 (DI = 4.328; DIT = 3.569; DM = 4.230; IWB = 4.052) and the median of all constructs were close to the means (DI = 4.750; DIT = 3.667; DM = 4.400; IWB = 4.200). None of the constructs obtained averages lower than the midpoints of the scales.

Table 9. Descriptive statistics of items for each construct.

	Mean	Median	Observed Min	Observed Max	Standard Deviation
DI1	4.365	5.000	2.000	5.000	0.873
DI2	4.459	5.000	1.000	5.000	0.837
DI3	4.343	5.000	2.000	5.000	0.789
DI5	4.144	4.000	2.000	5.000	0.766
DIT3	3.917	4.000	1.000	5.000	1.092
DIT4	3.365	3.000	1.000	5.000	1.239
DIT5	3.425	4.000	1.000	5.000	1.296

Table 9. *Cont.*

	Mean	Median	Observed Min	Observed Max	Standard Deviation
DM1	4.011	4.000	1.000	5.000	0.975
DM2	4.227	4.000	2.000	5.000	0.779
DM3	4.138	4.000	1.000	5.000	0.799
DM4	4.376	5.000	2.000	5.000	0.816
DM5	4.398	5.000	1.000	5.000	0.791
IWB1	4.309	4.000	1.000	5.000	0.837
IWB2	3.972	4.000	1.000	5.000	0.966
IWB3	3.646	4.000	1.000	5.000	1.150
IWB4	4.055	4.000	2.000	5.000	0.973
IWB5	4.276	5.000	1.000	5.000	0.842

DI = Digital Infrastructure; DIT = Digital Integration; DM = Digital Management; IWB = Innovative Work Behavior.

Table 10. Descriptive statistics of the constructs.

	Mean	Median
DI	4.328	4.750
DIT	3.569	3.667
DM	4.230	4.400
IWB	4.052	4.200

DI = Digital Infrastructure; DIT = Digital Integration; DM = Digital Management; IWB = Innovative Work Behavior.

4. Materials and Methods

4.1. Sample and Procedures

The present study was developed in a Federal Institution of Brazilian Higher Education, recognized for its wide representativeness in the Northern region of Brazil. The criteria for choosing this institution as the object of study was, first, due to the implementation of the Business Process Management (BPM) methodology. Second, the implementation of digital systems in the conduct of academic and administrative processes, including a User Service System, an Integrated Asset, Administration and Contracts System, an Integrated Academic Activities Management System, an Integrated Human Resources Management System and an Integrated Planning and Management System; these systems allow demands to be carried out electronically, generating procedural speed and human or material resource savings.

The conceptual research model was tested in a sample of 540 civil servants, composed of administrative technicians in education and teachers invested in a management function, each of whom already had experience with BPM and the digitization of administrative and/or academic processes. The sample was considered adequate for studies of this nature, considering that the PLS-SEM tool was used; this tool is characterized by being a robust technique that does not require assumptions and has few estimation problems, serving both small and large samples (Hair et al. 2017). The sample was acquired through two channels. First, a survey was carried out in the Process Management Portal of the Institution; this was performed to verify the sectors that have organizational processes already mapped in its repository. After identifying the sectors, it was investigated which work with digital processes; this was achieved through research carried out in the Portal of the Integrated Management System and on the website of the Commission of Electronic Administrative Process for the institution. Finally, the sectors that work with BPM but do not have digital processes were excluded. As such, the final sample of 540 employees, distributed in 12 sectors of the institution, was reached.

Regarding the data collection procedure, a pre-test of the questionnaire was performed to provide improvement in the quality of the items addressed and the correction of writing problems. As becoming a fundamental instrument for the research, this step was vital; it was carried out without great difficulties by the applicators and understood by the respondents, increasing the efficiency and efficacy of the study. The pre-test was applied from 25 to

27 May 2022, with ten specialists in the area (five administrative technicians in education and five teachers invested in a management function). Among the technicians, three presented suggestions for improvement regarding the understanding of the statements and the inclusion of items in the questionnaire; among the teachers, two presented suggestions for improvement regarding the understanding of the statements. After this feedback, the suggestions were integrated into the final version of the questionnaire. Subsequently, a total of 540 questionnaires (Appendix A) were sent between October and November 2022, of which 181 were returned, obtaining a response rate of 33.5%; this is representative considering the target audience, the data collection method, and the time required to answer the statements, and the results provided a solid basis for data analysis and confidence of empirical results. For online surveys, where there was no prior relationship with the recipients, a response rate of 20% to 30% is considered excellent. Participation occurred voluntarily and the study was confidential. Among the respondents, 50.3% were female and 45.3% were between 31 and 40 years old. Regarding the stocking unit, many of the research participants (30.9%) worked at the Institute of Geosciences (IG), followed by the Pro-Rectory of Personnel Development and Management (15.5%). In addition, 44.2% had a specialization/MBA and 32% had a Master's degree; of these, most had a degree in Business Administration (30.4%).

4.2. Measures

In order to measure the relationship between digital competence and innovative work behavior (IWB), a self-administered online questionnaire was constructed. This questionnaire was adapted from previous studies, including Dahiya and Raghuvanshi (2021); Redecker (2017); and Yu and Moon (2021). The questionnaire was organized in two stages. The first related to the constructs to be analyzed; the second related to the identification of the respondent's profile. Table 11 describes the items used to measure the various constructs: Digital Infrastructure, Digital Integration, Digital Management, and Innovative Work Behavior. These were measured based on a 5-point Likert scale. The choice of the Likert Scale for the research is justified because it is easy to understand and accessible to a large number of participants. The Likert Scale allows for more accurate results than other larger or smaller scales, as it provides enough responses to capture the nuance and variation in participants' opinions, is easily statistically analyzed, and makes survey results more reliable and easier to interpret.

Table 11. Definition of constructs.

Construct	Description	References
Digital Infrastructure (DI)	Refers to the institution's ownership and use of digital-related infrastructure.	(Redecker 2017; Yu and Moon 2021)
Digital Integration (DIT)	Refers to the institution's integration of various digital-related strategies, technologies and knowledge resources.	(Redecker 2017; Yu and Moon 2021)
Digital Management (DM)	Refers to the acquisition of competence and experience related to digital by the management of the institution.	(Redecker 2017; Yu and Moon 2021)
Innovative Work Behavior (IWB)	Behaviors of "individuals" directed to the intentional initiation and introduction of new and useful ideas, processes, products or procedures.	(Dahiya and Raghuvanshi 2021)

4.3. Data Analysis

The present research seeks to analyze and validate the proposed research model. For this, the Technique of Modeling Partial Least Square Structural Equations (PLS-SEM) was used in the SmartPLS 4 software package. The PLS-SEM statistical technique is mainly used to develop theories in exploratory research or to extend existing research by explaining the variance in the dependent variables when examining the model. This technique has been

widely adopted in social science research and is used to analyze multiple relationships between unobservable factors (Hair et al. 2017). Therefore, PLS-SEM was considered suitable for this study because the aim of the research is prediction and theory development, making PLS-SEM the most appropriate method. In addition, PLS-SEM facilitates working with a broader range of problems than, for example, the CB-SEM, given its ability to work efficiently with different sample sizes and more complex models; alongside this, its assumptions seem less restrictive about the data and it presents fewer estimation problems. Finally, PLS-SEM allows for the simultaneous estimation of multiple causal relationships between one or more independent variables and one or more dependent variables, and to explore data in search of patterns and relationships.

The analysis was based on two steps. First, the Measurement Model Test was performed, which shows the operationalization of constructs through a set of indicators. Its analysis assesses how much this set of variables represents the construct (Hair et al. 2017). Second, the Structural Model Test was performed, evidencing the constructs' relationships (paths).

5. Discussion, Implications, Limitations, and Future Research Directions

5.1. Discussion

This study investigated the influence of digital competence, through three central factors (infrastructure, integration, and digital management), on innovative work behaviors of public employees of a Brazilian Federal Higher Education Institution. The results indicate that support for digital competence can help the institution to achieve innovative behaviors. In this scenario, infrastructure, integration, and digital management are interdependent factors because they are linked in a continuous cycle; as such, it is up to the university's public management to lead them effectively. Otherwise, access to digital competence may be compromised, which, consequently, will negatively affect the innovative behavior of the individual.

We showed that digital infrastructure (DI) make a positive influence on innovative work behavior (IWB), confirming the first hypothesis. The findings confirm the understanding presented in previous research that states that digitization and the application of information technologies are an opportunity for improvement, as it paves the way for future innovations and research (Ciriza-Mendívil et al. 2022; Paschou et al. 2020). Employees are encouraged to propose innovative ideas that could add value to their demands when encountering technologies that improve their work processes and meet educational demands (Battistelli et al. 2013). Other studies empirically confirm that an environment of confidence in innovation and support from the management and the workforce allows employees to feel comfortable and safe in sharing innovative ideas (Afsar et al. 2015; Attiq et al. 2017).

This paper discusses aspects related to the organizational environment and contributes to knowledge about digital competence. We demonstrate that providing an efficacious digital infrastructure to acquire appropriate technologies for the work environment and necessary operational support for a public institution to generate innovative behaviors is necessary. The absence of a proper infrastructure will make the innovative process unfeasible. Access to digital technologies by public institutions provides employees with a range of possibilities for developing their potential to favor communication and the exchange of information, thereby encouraging greater participation in the construction of knowledge.

Our results indicated that digital integration influences innovative work behavior, confirming the research's second hypothesis. These results are consistent with other recent research that states that digital technology provides new ways to organize organizational activities, builds trust in the actors' ecosystem, and influences innovation (Weking et al. 2020). The readjustment of work processes to make them digital and integrate them into the organization's digital strategy is characterized as a procedure that involves changes, adaptations, and a certain degree of difficulty. Specifically, innovative actions could be valuable, especially when considering that the involvement of employees in the generation

and implementation of new and useful ideas would increase the likelihood of adaptation to changes and overcoming work-related difficulties (Battistelli et al. 2013).

Previous research has found that when an employee has autonomy and self-esteem, and feels confident in developing changes in their work processes, the chances of them engaging in innovative behaviors are higher (Attiq et al. 2017; Battistelli et al. 2013). Other studies claim that job crafting, a process by which employees could redesign processes to ensure a good fit with work, fortifies innovative work behaviors (Afsar et al. 2019). All these IWB determinants can aggregate and strengthen the relationship of digital integration with innovative behaviors at work.

Finally, digital management positively influences innovative work behavior, confirming the third hypothesis. Given the increasingly frequent use of digital technologies, both in teaching-learning processes and in public institutions' administrative processes, public service employees need to pursue training in digital competencies to acquire technological competence and know-how in order to develop both systems use competence and internal management competence to execute a given strategy (Kindermann et al. 2021). For example, Lego sees its employees' digital know-how as a key-factor enabler of its digital strategy (Sawy et al. 2016). Digitally strong organizations strive to acquire individuals to build and renew competence that allows them to digitize value-creation processes and outcomes.

Furthermore, research argues that knowledge sharing creates opportunities for innovative work behaviors (Afsar et al. 2019; Bos-Nehles and Veenendaal 2019). In this way, digital knowledge sharing could become a driving force for innovative behaviors. Other findings show that HR practices, such as training and development, reward, job safety, job demand, and feedback, are positively related to IWB (Bos-Nehles et al. 2017). Moreover, leadership styles, such as transformational leadership and leadership change member-leader, add freedom and autonomy to employees to carry out their work, inducing them to suggest innovative ideas and suggestions in the workplace (Afsar and Umrani 2020; Afsar et al. 2014; Atitumpong and Badir 2018). In addition, to stimulate innovative employee behavior, the public institution should promote training and digital-related rewards to provide leadership that supports employee participation in decisions and encourages innovation in the workplace (Sia et al. 2016).

5.2. Theoretical Implications

From a theoretical perspective, a key contribution of this research is the development of a new theoretical and empirically assessed model of relations between Digital Competence and Innovative Behavior at Work that enriches the literature. According to the researchers' knowledge and available information, this study investigates the perceptions of workers in public education institutions and their internal conditions (digital infrastructure, digital integration, and digital management) that influence innovative behavior at work. This investigation represents an advance in the formulation and conceptualization of the theory of individual behavior. This research confirms that the adoption of new technologies and digital management models are at the heart of advances in innovative behavior at work. Furthermore, the results are consistent with our arguments that organizations that continue to invest in technology and educational management are more inclined to implement innovative behavior actions at work as part of a workforce differentiation strategy.

Understanding the concept of innovative behavior contributes to analyzing specific occupations for innovation activities in research and development and new software acquisitions. On the one hand, this deepening improves the results in the education sector; it contributes to the investments and essential obligations necessary to overcome the impediment for both higher education institutions and public institution workers to invest in specific intermediate-level digital skills. On the other hand, it highlights the importance of widely distributed capabilities in the innovation-focused workforce. These findings contribute to the knowledge of technology-based educational management and innovative behavior, enrich the literature, and discuss, in general, how to agree on their training needs for innovative behavior. The role of public service managers and technicians is considered

to be a participatory vision, where the promotion of the new model of digital competence development is prioritized. This research alerts managers to the quality role of higher education in providing essential training for the development of new capabilities of the higher-level workforce. This research adds value to the management education literature by investigating innovative behavior at work from a developing Latin American country such as Brazil.

5.3. Managerial Implications

The results of this research provide several practical implications. First, educational managers should create practices that enable innovative behavior among employees. Given this scenario, it is recommended that university public management centralize the activities of Technological Innovation to strengthen digital competence and innovative behavior at work, expand the relationship between university-company and society, encourage dissemination and application of knowledge, innovation, and entrepreneurship, and to creating new cooperation, incubation of companies, and encourage technology transfer.

Second, educational managers should develop a new normative framework to be incorporated into the Institutional Development Plan (IDP), with guidelines for educational and technological innovation, and expand innovative behavior at work through the construction of an Integrated People Management Policy. On the other hand, recruitment and selection should adopt new criteria that assess the innovative behavior of the civil servant. The choice of employees to assume management positions should consider their innovative profile and/or the development of an innovative profile among current managers. Furthermore, when allocating employees to work units according to their professional profile, ensure that innovation is part of their employee profile. In addition, the training unit should create Learning Trails in Digital Competence, where the employee aims to carry out a sequence of training activities to acquire knowledge in digital competence and learn how to operate digital platforms. Such measures aim to mitigate potential digital gaps and strengthen innovative behaviors. In this line, digital competence enables the improvement of public service employees through training for digital technologies. Innovative employees can learn to reformulate work situations from an ecosystem perspective of innovation, bringing intentions to their interpersonal relationships.

Third, educational management in Federal Institutions of Higher Education should establish an effective digitization strategy. For this purpose, people management and information technology units need to provide an appropriate digital infrastructure in order to provide all necessary support for the use of information technologies.

By analyzing different dimensions of variables, this article can help educational managers in future developments and alert them in the process of building an information system. Educational institutions should pay attention to the value of innovation and technology content, rather than putting all the emphasis on traditional teaching and neglecting the essence of knowledge dissemination. On the other hand, during the innovation process, managers should encourage employees to express themselves and help them realize their innovative ideas, rather than just stopping at generating ideas. Moreover, this work can be used as a basis for decision making for educational managers to intervene in innovation and employee performance, to provide a theoretical basis for subsequent intervention strategies, and to help the public service to improve employees' work outcomes more effectively from a management perspective.

5.4. Limitations and Future Research Directions

In this context, Brazilian public management should consider digital competence as a fundamental factor to generate innovative work behavior among public employees. However, investment in technology does not guarantee innovative behavior, because other factors at the individual, group, and organizational level can influence and determine individual innovation to facilitate or inhibit its initiative in organizational contexts. In

addition, creating an environment and promoting innovative work behavior is a challenge for public institutions due to their very highly bureaucratic and traditional nature.

Despite the validation and confirmation of the hypotheses investigated, this study was limited to investigating the influence of digital competence on innovative work behaviors of public service employees in the context of a Brazilian Federal Higher Education Institution. Additional work is suggested to improve understanding and test the influence of new factors such as mediators/moderators in this relationship, including support from management and the work team, self-esteem and self-efficacy (Attiq et al. 2017), knowledge sharing (Afsar et al. 2019; Bos-Nehles and Veenendaal 2019), and training and development and reward and autonomy at work (Bos-Nehles et al. 2017).

Federal Institutions of Higher Education are important sites for the changing developments of innovative behavior at work. First, managers need to adapt to technological changes in education. In this paper, we do not observe how much educational strategy impacts the innovative behavior of employees. As a result of planning, it is expected that results will be achieved to boost educational performance. Thus, it is worth broadening the reflection on the decision to invest in projects of excellence that do not leave the research stage. On the other hand, more engaged leaders and employees contributing to the education institution's strategies promote the building of an innovative culture and a thriving IWB. In addition, systematic solutions for the implementation of result for sustainable innovation with the creation of a culture of innovation in education, where experimentation and risk are encouraged and ideas are valued, must be encouraged.

6. Conclusions

The digital competence of a university could have a significant impact on the innovative behavior of its employees, made up of students, professors, researchers, and managers. Well-developed Digital Infrastructure, Digital Integration, and Digital Management could provide an environment conducive to creativity and experimentation, allowing the realization of innovative projects that could result in significant benefits to society. With a robust technological infrastructure, students and researchers could work with advanced tools that assist them in exploring innovative ideas and quickly test them. These technologies could include computer simulations, data modeling, and other tools for real-time experimentation. In addition, a solid digital competence could support external collaboration among university members, both locally and globally. High-speed networks enable real-time communication with other researchers on a global scale, which can lead to new ideas and innovative solutions.

One of the strategies for a Federal Higher Education Institution (IFES) to become innovative is by obtaining innovative behaviors from public officials. Given this context, IFES must identify and improve the infrastructure, integration, and digital management that influence the innovative work behavior of these employees. This study identified new elements that influence innovative work behavior. The results support the theoretical support of the conceptual structure of this research and indicate that the adoption of digital competence stimulates innovative work behaviors in public service employees. Therefore, this research provides a new perspective to IFES managers in Brazil to identify how the factors of digital competence can influence behaviors aimed at innovation at work.

Thus, IFES in Brazil, which intend to stimulate innovative behaviors in the organizational environment, need to understand the process of achieving digital competence in order to consider all its factors (infrastructure, integration, and digital management), which are interdependent and are linked to each other in a continuous cycle. First, an IT infrastructure should be made available as part of the organizational strategy in order to meet the needs of the organization. Then, effective integration of digital technologies to work processes must be promoted, and possible bottlenecks to integration must be identified and mapped in order to propose solutions. Finally, the knowledge related to the use of digital technologies in the organization must be managed in order to obtain the necessary knowledge to operate the systems and be always digitally up to date.

It is also important to ensure that the instruments applied to ensure digital competence development meet adequate levels of reliability and validity (Saltos-Rivas et al. 2021). The assessment of the real level of digital competence is a research gap indicated by Zhao et al. (2021), implying in the need for new investigations, especially considering the matter of validation and reliability previously indicated. In complement to the public higher education perspective, future research can also apply a similar investigation to private higher education institutions.

Author Contributions: Conceptualization, L.P.d.C. and T.P.; methodology, L.P.d.C. and T.P.; software, L.P.d.C. and T.P.; validation, L.P.d.C. and T.P.; formal analysis, L.P.d.C. and T.P.; investigation, L.P.d.C. and T.P.; resources, L.P.d.C. and T.P.; data curation, L.P.d.C. and T.P.; writing—original draft preparation, L.P.d.C. and T.P.; writing—review and editing, L.P.d.C., T.P., C.C.R., F.d.A.R., V.D.H.d.C. and T.C.C.N.; visualization, L.P.d.C., T.P., C.C.R., F.d.A.R., V.D.H.d.C. and T.C.C.N.; supervision, L.P.d.C., T.P., C.C.R., F.d.A.R., V.D.H.d.C. and T.C.C.N.; project administration, L.P.d.C., T.P., C.C.R., F.d.A.R., V.D.H.d.C. and T.C.C.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Acknowledgments: This research was partially supported by the Federal University of PARA and Dean of Research and Graduate Studies—PROPESP—The authors would like to acknowledge the National Council for the Improvement of Higher Education (CAPES) a foundation affiliated with the Ministry of Education in Brazil.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Questionnaire

Digital Infrastructure Refers to ownership and use of digital-related infrastructure by the institution.
DI1. You use different digital technologies (emails; applications such as: whatsapp, telegram, instagram and facebook; website and information systems of the institution, such as: SIGAA, SIPAC, SIGRH, SAGITTA and/or SINPEG) to improve communication with the community university. 1. I do not use digital technologies for communication. 2. I use basic digital technologies for communication, for example: e-mail. 3. Sometimes I combine different digital technologies for communication. 4. Occasionally, I select, adjust and combine different digital solutions to communicate effectively. 5. I often reflect, discuss and proactively develop my communication strategies, in order to adopt the technologies that best suit my reality.
DI2. You use digital technologies (emails; messaging apps such as: whatsapp and telegram; videoconferencing platforms, such as: google meet, zoom and teams; cloud file storage platforms, such as: google drive and onedrive; management information systems, such as: SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG) to work with colleagues inside and outside your institution. 1. It is not possible in my work context. 2. I rarely have the opportunity to use digital technologies to work with colleagues. 3. I sometimes use digital technologies to work with colleagues inside and outside my institution. 4. I occasionally use digital technologies to work with colleagues inside and outside my institution. 5. I frequently use digital technologies to work with colleagues inside and outside my institution.

DI3. You carefully consider how, when and why to use digital technologies in your unit's work processes to ensure they add value.

1. I do not use digital technologies in my work processes.
2. I rarely make basic use of available digital technologies.
3. Sometimes I use some digital resources and tools to solve specific problems in my work processes.
4. I occasionally use digital technologies to improve the execution of my work processes.
5. I often use various digital technologies to implement innovative strategies in my work processes.

DI4. In your perception, the digital infrastructure of your institution's information systems (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG) is capable of meeting the needs of work processes in your unit.

1. I have not yet had the opportunity to work with the information systems at my institution.
2. My institution's information systems do not meet the needs of my work processes.
3. My institution's information systems barely meet the needs of my work processes.
4. My institution's information systems satisfy, to a large extent, the needs of my work processes.
5. My institution's information systems fully satisfy the needs of my work processes.

DI5. You have adequate digital knowledge and skills to use your institution's digital infrastructure (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG).

1. This is a new area that I haven't considered yet.
2. Not yet, but I'm definitely interested in acquiring these skills.
3. I have insufficient digital knowledge and skills to use my institution's digital infrastructure.
4. I have reasonable digital knowledge and skills to use my institution's digital infrastructure.
5. I have excellent digital knowledge and skills to utilize my institution's digital infrastructure.

Digital Integration

Refers to the institution's integration of various digital-related strategies, technologies and knowledge resources.

DIT1. In your perception, his Unit's Development Plan (UDP) is integrated with the institution's digital strategy, in order to contemplate the use of digital technologies (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG).

1. My work unit does not intend to integrate the institution's digital strategy.
2. Digital strategy is a new area that has not yet been considered in UDP of my unit.
3. Not yet, but my work unit is definitely interested.
4. Not yet, but my work unit is reformulating its UDP to include the digital strategy.
5. Yes, the UDP of my unit is integrated into the institution's digital strategy.

DIT2. In your perception, your work unit integrates digital technologies in all its subunits, through the use of the institution's information systems platforms (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG).

1. Digital integration is not possible in my work unit.
2. My work unit does not intend to integrate digital technologies into its subunits.
3. My work unit integrates digital technologies in some subunits.
4. My work unit integrates digital technologies into most of its subunits.
5. My work unit integrates digital technologies into all its subunits.

DIT3. In your perception, your institution's information systems (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG) enable the integration of data between different subunits.

1. My institution's information systems do not allow the integration of data between different subunits.
2. My institution's information systems allow insufficient integration of data between different subunits.
3. My institution's information systems allow a reasonable integration of data between several subunits.
4. My institution's information systems allow good integration of data between different subunits.
5. My institution's information systems allow for excellent integration of data across multiple subunits.

DIT4. You are able to freely share and use data from other subunits through the institution's information systems (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG).

1. I do not use the institution's information systems to share and use data.
2. I am not able to freely share and use data from other subunits through the institution's information systems.
3. I am reasonably able to basically use the institution's information systems to freely share and use data from other subunits.
4. Optimally, I am able to search the institution's different information systems for data from other subunits to share and use freely.
5. Excellently, I am able to combine different information systems of the institution to freely share and use data from other subunits.

DIT5. You consider and address potential practical or technical difficulties in making digital services available to the university community.
For example: "interoperability and conversion issues, lack of digital skills".

1. I don't create digital services.
2. I do not consider potential difficulties, as students, teachers and/or technicians have no problems using digital technology.
3. I basically adapt digital services to minimize difficulties.
4. I discuss possible obstacles with students, teachers and/or technicians and outline solutions to potential difficulties.
5. I address a variety of possible difficulties, for example, adapt services, discuss solutions and provide alternative paths.

Digital Management
Refers to the acquisition of skills and experience related to digital by the management of the institution.

DM1. You actively develop your skills in digital technologies.

1. I don't have time to improve my skills in digital technologies.
2. I rarely improve my skills through reflection and experimentation.
3. I sometimes use a variety of digital resources to develop my skills at work.
4. Occasionally, I discuss with colleagues how to use digital technologies to innovate and improve work processes.
5. I often develop, and help colleagues develop, strategies to improve the use of digital technologies at work.

DM2. You participate in online training when you have the opportunity. (For example: online courses, webinars, virtual conferences).

1. This is a new area that I haven't considered yet.
2. Not yet, but I'm definitely interested.
3. I attended online training once or twice.
4. I occasionally participate in some online training.
5. I often participate in all kinds of online training.

DM3. From the digital training offered by the institution, you apply the skills and knowledge of digital systems (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG).

1. This is a new area that I haven't considered yet.
2. I still can't apply my knowledge of digital systems.
3. Apply basic knowledge of digital systems.
4. I apply intermediate knowledge of digital systems.
5. I apply complex knowledge of digital systems.

DM4.You use the institution's digital systems (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG) to solve internal and external demands related to your work processes.

1. I don't use digital systems.
2. I don't need digital systems to solve internal and external demands.
3. Sometimes, I use digital systems to solve internal and external demands.
4. Occasionally, I use various digital systems to solve internal and external demands.
5. I often integrate different digital systems to solve internal and external demands.

DM5. You plan, document and monitor your work processes using digital technologies. For example: use of videoconferencing platforms (google meet, zoom, teams), cloud file storage platforms (google drive, onedrive), management information systems such as: SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG.

1. It is not possible in my work context.
2. I do not adopt digital technologies in my work context.
3. Sometimes I use, for example, a cloud file storage platform to store documentation.
4. I occasionally use digital technologies to plan, document and monitor my work processes.
5. I often integrate different digital technologies to plan, document and monitor my work processes.

Innovative Work Behavior
It refers to behaviors of "individuals" directed towards the intentional initiation and introduction of new and useful ideas, processes, products or procedures.

IWB1. You look for opportunities to improve processes or services provided to the university community.

1. I do not look for opportunities to improve my work processes.
2. I rarely look for opportunities to collaborate on improving my work processes.
3. Sometimes I look for opportunities to improve my work processes.
4. I occasionally look for opportunities to improve my work processes.
5. I often look for opportunities to improve my work processes.

IWB2. You generate ideas or solutions to improve services provided to the university community.

1. I do not generate ideas or solutions to improve my work processes.
2. I rarely generate ideas and/or solutions to improve my work processes.
3. Sometimes I generate ideas and/or solutions to improve my work processes.
4. Occasionally, I generate ideas and/or solutions to improve my work processes.
5. I often generate ideas and/or solutions to improve my work processes.

IWB3. You participate in debates and meetings in order to contribute new ideas to your Unit Development Plan (PDU).

1. I have no interest in contributing new ideas to my unit's PDU.
2. Not yet, but I am interested in attending meetings to contribute new ideas to my unit's PDU.
3. I sometimes attend meetings to contribute innovative ideas to my unit's PDU.
4. I occasionally participate in meetings in order to contribute innovative ideas to my unit's PDU.
5. I often participate in meetings to contribute innovative ideas to my unit's PDU.

IWB4. You encourage and encourage co-workers in the implementation of new ideas in favor of improving service to the university community.

1. I have no interest in encouraging coworkers to implement new ideas.
2. I rarely encourage my co-workers to implement new ideas.
3. Sometimes, I exchange experiences with colleagues in order to encourage them to implement new ideas to improve work processes.
4. Occasionally, I work with colleagues to propose improvements in work processes.
5. I frequently exchange ideas with colleagues in order to encourage them to add improvements to work processes.

IWB5. You adopt the institution's digital systems (SIGAA, SIGRH, SIPAC, SAGITTA and/or SINPEG) in your work processes, with the aim of improving the fulfillment of demands from the university community.

1. It is not possible in my work context.
2. I do not use the institution's digital systems in my work processes.
3. I adopt some of the institution's digital systems in my work processes.
4. I adopt several digital systems of the institution in my work processes.
5. I adopt all the institution's digital systems that can be used in my work processes.

Respondent Profile Identification	Answers
Sex	( ) Female ( )male
Age Range	( ) 18–30 years old ( ) 31–40 years old ( ) 41–50 years old ( ) Over 51 years old
Work Unit	( ) Pro-Rectory of Undergraduate Education (PROEG) ( ) Pro-Rectory of Research and Graduate Studies (PROPESP) ( ) Pro-Rectory of Extension (PROEX) ( ) Pro-Rectory of International Relations (PROINTER) ( ) Pro-Rectory of Administration (PROAD) ( ) Pro-Rectory of Personnel Development and Management (PROGEP) ( ) Pro-Rectory of Planning and Institutional Development (PROPLAN) ( ) City hall ( ) Information and Communication Technology Center (CTIC) ( ) Central Archive ( ) Technological Innovation Agency (UNIVERSITEC) ( ) Institute of Geosciences (IG) ( ) Other_____
Education Level	( ) Complete Elementary School ( ) Complete High School ( ) Complete Higher Education ( ) Graduate at the Specialization/MBA level ( ) Graduate at the Master's level ( ) Graduate at the Doctorate level ( ) Post-Doctorate
knowledge Area	( ) Administration ( ) Archivology ( ) Librarianship ( ) Accounting Sciences ( ) Economic Sciences ( ) Engineering ( ) Information Technology ( ) Other_____

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