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Factors of Cloud Computing and Digitization of SMEs in Peru using PLS-SEM Structural Analysis

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Abstract

The objective of this research is to determine the main factors of cloud computing that explain the variability of the digitalization of SMEs in Peru. The type of research is basic, with a quantitative approach, at the explanatory level, with a non-experimental design, and a sample of 211 SMEs in Peru. The research concludes that there is a significant influence of cloud computing and certain factors in the digitalization of SMEs in Peru. An exploratory factor analysis (EFA) was carried out, obtaining values above 0.90 for the Kaiser-Meyer-Olkin tests, as well as the Barlett's sphericity test p=0.000 and the analysis of variance explained by 66.26% for cloud computing and 68.28% for the digitalization of SMEs, determining that the interrelation of the items is satisfactory. Confirmatory factor analysis (CFA) was applied, obtaining values for CFI=0.901, and TLI=0.890, being close to 1, thus determining that the models are appropriate and give validity to the construct. Additionally, construct validity is performed by PLS-SEM analysis of the model. The research determines that there is a moderate to strong correlation of part of the factors of cloud computing in the digitalization of SMEs, through Spearman's correlation coefficient obtaining values higher than 0.685, as well as through the ordinal regression that through the Pseudo R-squared in the Nagelkerke indicator obtained 80% and in the model adjustment obtaining Sig = 0.00. These results were contrasted with the bootstrapping method through the PLS-SEM analysis obtained for the T-statistic values greater than 2, as well as for the P-values lower than 0.05, these results determine that there is a causal relationship between the factors of cloud computing and digitalization of SMEs.

Keywords: *Cloud Computing, SME Digitalization, SEM Model, SEM Model.*

INTRODUCTION

Digitization and cloud computing globally, nationally, and regionally are in great process of implementation and use by large companies, however, this is still not common in small businesses in Peru, because some barriers or difficulties prevent them from adopting and making use of new technologies such as cloud computing (Peillon & Dubruc, 2019).

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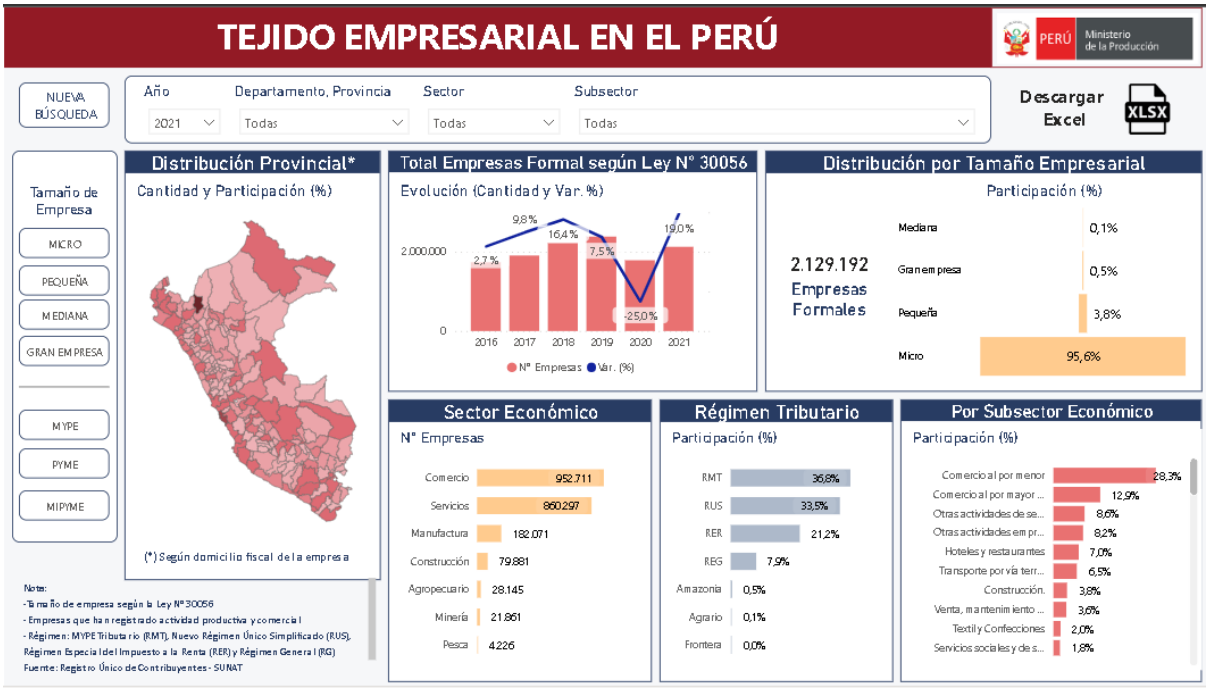
In Peru, small businesses represent 95.6% of companies nationwide, according to the report of the Ministry of Production, as shown in Figure 1.

Figure 1 Distribution by business size in Peru 2021



Note. Website of the Peruvian Business Fabric - Ministry of Production.

Khayer et al. (2020) report that cloud computing has not currently experienced widespread adoption among small businesses. The possible reasons are diverse and subject to study, among them the lack of industry-specific standards, poor technology, lack of awareness of the potential benefits of this technology, unsatisfactory quality of cloud services, and the mismatch between initial expectations and experience (Akar & Mardiyan, 2016). Lack of knowledge of relative advantage was identified as one of the main reasons for SMEs not adopting cloud computing (Amron et al., 2017). Another critical issue that inhibits the uptake of cloud computing or leads to its low use is the concern about the security and privacy of resources stored on a third-party server (Khayer et al., 2020). In addition, attributes of decision actors (i.e., self-efficacy, resistance to change, hedonic drives, and social influence) may hinder the adoption of cloud computing by SMEs. On the other hand, the strategies developed by cloud providers focused on attracting new customers in this niche, remain ineffective and inadequate to facilitate cloud adoption (Sultan, 2011).

It is necessary to know and analyze the main problems faced by SMEs in Peru to achieve digitalization (Hamidinava et al., 2023). Also identify which business operations should be prioritized in the adoption of cloud computing in a scalable manner (Rehm & Goel, 2017). The pandemic has highlighted the great gap and competitive disadvantage that small businesses have in the country, demonstrating the lack of resilience to the new needs that have arisen. The pandemic also revealed a great weakness in the adaptation of companies to digitalization, some of which have been mitigated by using social networks (Saguy, 2022). However, it is necessary the use enterprise information systems that allow them to be competitive and give the necessary growth to their business operations through the adoption of cloud computing (Ansong & Boateng, 2023).

The social impact of this study is relevant since the scientific method was used to verify the factors of cloud computing that affect the digitization of SMEs in Peru (Liu et al., 2022). In this way, it was possible to determine factors that influence the digitalization of SMEs (Haddara et al., 2021). Considered in different studies that in the face of the

pandemic and globalization, the resilience of companies is largely due to their digitalization processes, for which the work in the cloud and social networks have allowed the survival of many companies at the local, national, and global level (Xie et al., 2022).

The economic impact is influential because small businesses represent more than 95% of the companies in Peru. The survival and growth of small and microenterprises strengthen the growth of the economy in society and with all stakeholders, suppliers, and customers as well as future investors (Marston et al., 2011).

MATERIAL AND METHODS

The research is defined as basic considering the quantitative approach because it seeks to identify the factors of cloud computing that influence the digitization of SMEs in Peru (Hernández et al., 2014, p. 48); the level is explanatory, the design is non-experimental, the scope of the study is SMEs located in Peru, the unit of study is composed of SMEs that are users and have access to technology and digitalization of their business processes.

According to the Peruvian Ministry of Production, companies are categorized by size: Micro, Small, Medium, and Large Enterprises. The present research considers as the unit of analysis the Micro and Small enterprise also called MYPES, being these a total of 380 formal companies reported by the PRODUCE portal for the year 2022 in the Tacna region - Peru.

Simple random sampling was used, considering a confidence level of 97%, z=2.17, variability of p=0.5, error at 5%, and population size of 380 SMEs, the sample is 211 SMEs in the Tacna region.

The research used the survey technique; for the Cloud Computing variable, the Guy-Bertrand Kamga (2022) questionnaire was adopted, which had 27 questions in total, with 14 questions for the Service Model dimension, 7 questions for the Cost of Ownership dimension and 8 questions for the Security dimension. For the dependent variable Digitalization of SMEs, the Produce questionnaire of the Ministry of Production (2022) was adapted, with 9 questions for the E-commerce dimension and 9 questions for the Digital Marketing dimension, the variables being Likert scale and ordinal, with values from 1 to 5, 5 being the highest knowledge and use concerning the observable variable.

For the instrument of the dependent variable digitalization of SMEs and the instrument of the independent variable cloud computing, Kaiser-Meyer-Olkin tests were performed as well as Bartlett's test; the values obtained for KMO are higher than 0.90, as well as Barlett's test of sphericity is significant giving p = 0.000; which means that the interrelation between the items is satisfactory, therefore, it corresponds to use the exploratory factor analysis (Pérez et al., 2013).

The total variance explained for the instrument Cloud computing shows three factors that give an accumulated 66.26%; likewise, for the instrument Digitalization of SMEs, two factors were obtained and an accumulated 68.28%, which indicates that it is an adequate percentage and denotes the variability of the information.

The confirmatory factor analysis was performed, where it was determined that both instruments showed results close to 1, both the instrument for the cloud computing variable and the instrument for the SMEs digitalization variable, so it can be deduced that they are appropriate models and give validity to the construct, according to Table 1 and Table 2.

Table 1 Adjustment Measures Cloud Computing

				IC 90% of RMSEA			
CFI	TLI	SRMR	RMSEA	Inferior	Superior	AIC	BIC
0.901	0.890	0.0422	0.0856	0.0777	0.0936	8120	8391

Table 2 SME Digitalization Adjustment Measures

				IC 90% of RMSEA			
CFI	TLI	SRMR	RMSEA	Inferior	Superior	AIC	BIC
0.866	0.846	0.0559	0.130	0.119	0.141	6049	6223

To reaffirm the validity of the construct, structural models are applied. According to Ramírez et al. (2014), to provide validity and reliability of the model, internal validity, construct reliability, convergent validity, and discriminant validity should be considered among them.

As shown in the results of Table 3, the values are close to 1, for Cronbach's alpha, because the high construct reliability can be confirmed, and also the AVE values exceed 0.5, so there is convergent validity. Since the results of the AVE exceed 0.70 or close to it, it is possible to affirm that the indicators are reliable. Since the AVE is greater than 0.50 and the external loadings exceed 0.70, it can be affirmed that the average of the construct explains more than 50% of the variance of the indicators.

Table 3 Validity of internal consistency and convergent validity

	Cronbach's alpha	rho_A	Composite reliability	Average variance extracted (AVE)
VD	0.893	0.896	0.949	0.903
VI	0.874	0.876	0.923	0.799
VID1	0.949	0.951	0.955	0.602
VID2	0.941	0.945	0.951	0.737
VID3	0.932	0.933	0.944	0.678

The Fornell-Larcker criterion compares the square root of AVE, as shown in Table 4, are higher than the correlations it maintains with any other construct.

Table 4 Discriminant validity

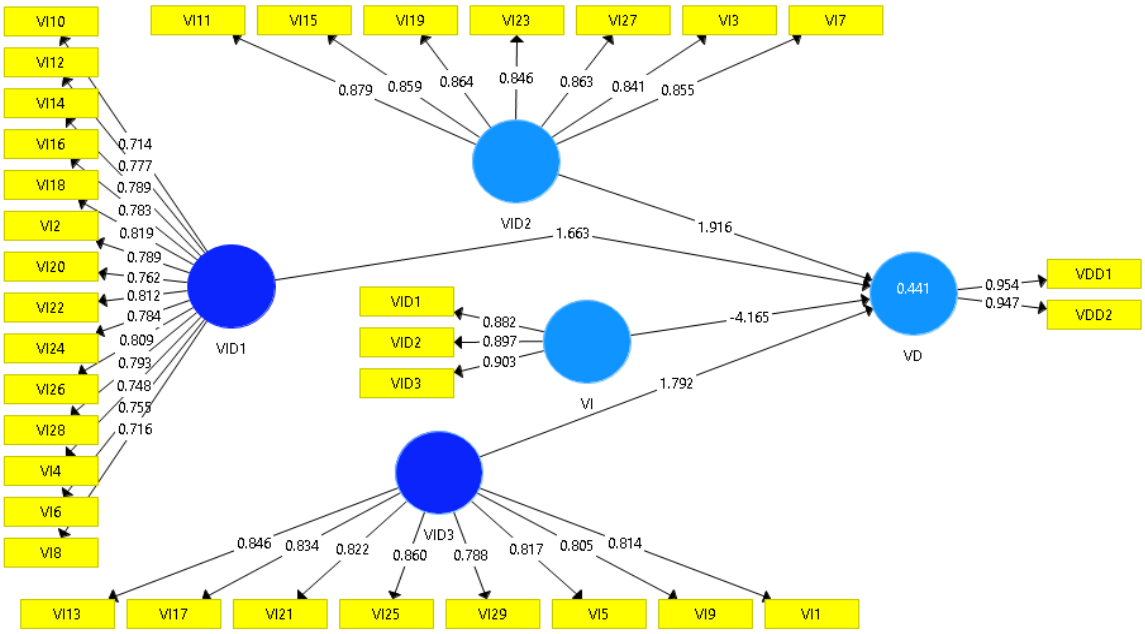
Fornell-Larcker criterion

	VD	VI	VID1	VID2	VID3
VD	0.950				
VI	0.636	0.894			
VID1	0.552	0.883	0.776		
VID2	0.593	0.898	0.685	0.858	

VID3	0.577	0.899	0.701	0.713	0.824

Using SMARTPLS software version 3.3 has allowed the verification of the construct validity of the proposed model as shown in Figure 2

Figure 2 Construct validity of PLS-SEM model



RESULTS

Spearman's correlation is used as a suitable method for non-normal distributions, which is the case of the sample used, allowing to determine the measure of linear association between the independent and dependent variables, in this case, the dimensions, finding results above 0.685.

Table 5 Correlations

			Digitization of SMEs	Cloud computing	Security	Cost ofOwnership	Service Model
Spearman's Rho	Digitization of SMEs	Correlation coefficient	1.000	.685**	.580**	.647**	.588**
		Sig. (bilateral)	.	.000	.000	.000	.000
		N	211	211	211	211	211
	Cloud computing	Correlation coefficient	.685**	1.000	.847**	.864**	.866**
		Sig. (bilateral)	.000	.	.000	.000	.000
		N	211	211	211	211	211
	Security	Correlation coefficient	.580**	.847**	1.000	.684**	.651**

	Sig. (bilateral)	.000	.000	.	.000	.000
	N	211	211	211	211	211
Cost of Ownership	Correlation coefficient	.647**	.864**	.684**	1.000	.646**
	Sig. (bilateral)	.000	.000	.000	.	.000
	N	211	211	211	211	211
Service Model	Correlation coefficient	.588**	.866**	.651**	.646**	1.000
	Sig. (bilateral)	.000	.000	.000	.000	.
	N	211	211	211	211	211

**. The correlation is significant at the 0.01 level (bilateral).

Ordinal regression is part of generalized linear models (GLM) (Pallarés Mestre, 2016). This type of model, equivalent to the coefficient of determination R2, explains the variability of the dependent variable digitization of SMEs associated with the independent variable Cloud computing.

The Pseudo-r-squared value explains the variability of the model, thus we can observe that the Nagelkerke indicator explains the dependent variable by 80%, according to Table 6.

Table 6 Pseudo R square

Cox y Snell	.799
Nagelkerke	.800
McFadden	.253

Liaison function: Logit.

According to Manotas et al. (2014) refer that for the validation of the model and testing of the hypothesis in the ordinal regression model will be used the results of the information on model fit. According to the results of Table 7 the p-value of the test is less than 0.05, then the null hypothesis is rejected, with this is determined by approving the proposed alternative general hypothesis, where Cloud Computing significantly influences the Digitization of SMEs in Peru.

Table 7 Model fit information

Model	Logarithm of the likelihood -2	Chi-square	gl	Sig.
Intersection only	1296.936			
Final	958.602	338.334	93	.000

Liaison function: Logit.

Table 8 Goodness of fit

	Chi-square	gl	Sig.
Pearson	138234.035	4230	.000
Desvianza	940.311	4230	1.000

Liaison function: Logit.

To test the hypothesis of the structural model and to determine whether the amount of variance of the endogenous variable is explained by the constructs found that predict it, the explained variance was used. Bootstrapping analysis was used to examine the stability of the estimates provided by the PLS analysis, which is performed by resampling all the data as if it were a population. Chin (1998) states that the two-tailed Student's t-test with n-1 degrees of freedom is calculated, where n is the number of subsamples applying significance levels. The results show that the T-statistic is greater than 2, which determines the significance is as always the P-value, in this case, the hypotheses are fulfilled being less than 0.05, according to Table 9.

Table 9 Hypothesis testing path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	Statistics t (|O/STDEV|)	P Values
VI -> VD	-4.165	-4.803	1.323	3.147	0.002
VID1 -> VD	1.663	1.895	0.441	3.771	0.000
VID2 -> VD	1.916	2.166	0.535	3.579	0.000
VID3 -> VD	1.792	2.025	0.523	3.424	0.001

DISCUSSION

The results obtained in the present research offer a clear view of the main factors to consider in the adoption of cloud computing in small and medium enterprises SMEs in Peru these are the service model, the cost of ownership, and security, having determined that the cost of ownership explains the variability of the digitization of SMEs given that in the Pseudo R square using the Nagelkerke Indicator resulted in 47% and the model fit P = 0, this coincides in the research of Yoo & Kim (2018), which aimed to demonstrate the factors related to the digitization of SMEs in a city in Thailand, obtaining the result 58%. So also, in coincidence with that proposed by (Khanda & Doss, 2018) who obtained similar results in a remote city in China.

La mejora en la digitalización de las PYMES, así como el coste de propiedad y la seguridad observados en la presente investigación coinciden con estudios anteriores, lo que pone de relieve la capacidad transformadora de la computación en nube en entornos empresariales de menor escala. Sin embargo, es crucial abordar las dificultades identificadas para garantizar una implantación satisfactoria (Khanda & Doss, 2018; Priyadarshinee et al., 2017).

The implementation of cloud computing and its influence on the digitization of SMEs has proven to be a significant catalyst for operational efficiency and cost reduction impacting the digitization of SMEs, aspects that find support in the results of this study given that in the Pseudo R-squared using the Nagelkerke Indicator resulted in 52.77% and the model fit P = 0. However, it is imperative to address the economic complexities and cost-related challenges to gain a holistic understanding of the adoption of this technology (Ogunlolu, 2019; Buyya et al., 2009; Buyya et al., 2009; Shrivastava & Riaz, 2022).

The reduction in operating costs, especially in terms of initial investment in local infrastructure and server maintenance, is in line with existing literature. This decrease in expenses can be a determining factor for small businesses, which often operate on tight budgets. However, it is essential to consider not only upfront costs but also long-term costs, such as subscription fees, maintenance, and potential hidden costs (Alshamaila et al., 2013; Yang, Chang, et al., 2021; Gangwar et al., 2015).

The scalability offered by the cloud translates into the ability to adjust resources according to business needs, which can significantly optimize economic efficiency. However, challenges related to accurate cost prediction were identified, as the cloud pricing model can be complex and variable. Accurate financial planning and careful resource management become imperative to maximize economic benefits (Assante et al., 2016; Vasiljeva et al., 2017).

In terms of resistance to change, small businesses may encounter economic challenges associated with training staff and adapting internal processes. Investment in training programs and time spent on the transition may generate short-term economic concerns, but these costs are expected to be offset by long-term benefits (Al-Aqrabi et al., 2015; Ibrahim & Abdullah, 2023).

It is crucial to note that despite the identified economic challenges, the general trend points to cloud computing offering a favorable economic proposition for small businesses and the adoption of cloud computing to be able to enhance the digitization of SMEs (Tutunea, 2014; Hassan, 2017; Hosseini et al., 2019). The ability to reduce costs, improve efficiency and provide financial flexibility positions the cloud as a strategic tool for the economic growth and sustainability of small businesses in today's business landscape (Han & Trimi, 2022; Hari et al., 2022; Yang et al., 2021).

Cloud computing security is a complex topic that requires careful assessment and a thorough understanding of the specific needs and requirements of each SMB. Education, transparency on the part of providers, and the implementation of sound security practices can significantly contribute to overcoming negative perceptions and ensure a secure cloud environment for small businesses. These statements are consistent with what Priyadarshinee et al. (2017) mentioned and find support in the results of this study given that the security factor in cloud computing and its influence on the digitization of SMEs was obtained as a result in the Pseudo R square using the Nagelkerke Indicator a 45.1% and the model fit P = 0.

CONCLUSIONS

The present research has been able to determine the construct validity regarding the factors of cloud computing found that influence the digitalization of SMEs in Peru, through the validation of the exploratory factor analysis obtaining values for KMO higher than 0. 90, as well as in the Barlett's sphericity test being significant given p = 0.000, which validates the interrelation between the items, being satisfactory, the total variance explained for cloud computing obtained 66.26% and the digitization of SMEs obtained 68.28%, indicating a quite adequate percentage and denotes the variability of the information. The models were validated with confirmatory factor analysis, obtaining values close to 1, for CFI=0.901, TLI=0.890, RMSEA=0.0856, AIC=8120, and BIC=8391. By means of structural models the validity of the construct has been corroborated, determining high construct reliability, due to AVE values exceeding 0.70 or close, due to external loadings exceeding 0.7, it is stated that the average of the construct explains more than 50% of the variance of the indicators.

Using Spearman's correlation coefficient, it is determined that cloud computing correlates with 68.5%, security by 58%, cost of ownership by 64.7%, and service model by 58.8% concerning SME digitization.

The Pseudo-r squared value explains the variability of the model, this was determined by the Nagelkerke indicator that 80% was obtained to explain the digitization of SMEs.

The testing of the hypothesis is given by adjusting the models and the goodness of fit where it was obtained that the significance value for p-value is less than 0.05, then the null hypothesis is rejected and the alternative hypothesis is approved, determining that cloud computing influences cloud digitization.

To corroborate the stability of the estimates, PLS analysis was used, through a resampling considering all the data as if they were a population, where it is determined that the T-value must be greater than 2 and the P-value less than 0.05, so it is concluded that the Service Model explains the digitization of SMEs because the T-value=3 was obtained. 147 and P-Value=0.002, the Cost of Ownership explains the digitization of SMEs because the value T=3.771 and P-Value=0.000 was obtained, the Security explains the digitization of SMEs because the value T=3.424 and P-Value=0.001 was obtained.

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