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FACTORES RELATED TO DIGITAL MATURITY AND TRANSFORMATION IN MANUFACTURING SMES IN NUEVO LEÓN

FACTORES RELACIONADOS CON LA MADUREZ Y TRANSFORMACIÓN DIGITAL EN LAS PYMES MANUFACTURERAS DE NUEVO LEÓN

Elva Patricia Puente Aguilar[a]
Autonomous University of Nuevo Leon, Mexico
(elva.puenteagl@uanl.edu.mx) (https://orcid.org/0000-0001-7129-3654)
Antonio Lucas Marmol
International Iberoamerican University, Spain
(antonio.lucas@unini.edu.mx) (https://orcid.org/0009-0009-7810-9018)
Carolina Solís Peña
Autonomous University of Nuevo Leon, Mexico
(carolina.solispa@uanl.edu.mx) (https://orcid.org/0000-0002-0918-1034)

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ABSTRACT

The objective of this research is to determine the factors related to the digital maturity of manufacturing SMEs in the state of Nuevo León, in order to contribute to the knowledge about their digital transformation. Through the literature review, five independent variables were defined: knowledge absorption capacity, level of technological infrastructure, organizational culture, innovation capacity and company environment; as a dependent variable, the degree of digital maturity was defined. The research design was quantitative, cross-sectional, with an exploratory and descriptive correlational scope. A survey was designed for data collection and validated by a panel of experts in the field. To check its reliability, a pilot test was conducted, and Cronbach's Alpha was measured. It was then applied to employees and managers of 69 manufacturing SMEs in the state. From the data, a multiple linear regression model was generated in SPSS software, which was subjected to various statistical tests to evaluate the variables and their significance. The model was approved. The results indicated that three of the variables, knowledge absorption capacity, level of technological infrastructure and company environment were significant with a p-value < 0.05. Additionally, specific analyses were recommended for the two variables that were not accepted. From the statistical analysis, an equation was obtained to measure the degree of digital maturity in manufacturing SMEs in Nuevo León that contributes to

[a] Corresponding author.

the progress in the digital transformation of manufacturing companies in the state.

RESUMEN

Palabras clave:
madurez digital, pymes manufactureras, transformación digital.

El objetivo de esta investigación es determinar los factores relacionados con la madurez digital de las Pymes manufactureras del estado de Nuevo León, a fin de contribuir en el conocimiento sobre su transformación digital. Mediante la revisión de literatura se definieron cinco variables independientes, capacidad de absorción del conocimiento, nivel de infraestructura tecnológica, cultura organizacional, capacidad de innovación y entorno de la empresa; como variable dependiente, se definió el grado de madurez digital. El diseño de la investigación fue cuantitativo, transversal, con alcance exploratorio y descriptivo correlacional. Se diseñó una encuesta para recopilación de datos que fue validada por un panel de expertos en el área. Para comprobar su fiabilidad, se realizó una prueba piloto y se midió el Alpha de Cronbach. Posteriormente se aplicó a empleados y directivos de 69 empresas Pymes manufactureras del estado. A partir de los datos se generó un modelo de regresión lineal múltiple en el software SPSS, el cual se sometió a diversas pruebas estadísticas para evaluar las variables y su significancia. El modelo resultó aprobado. Los resultados indicaron que tres de las variables, capacidad de absorción del conocimiento, nivel de infraestructura tecnológica y entorno de la empresa resultaron significativas con un p-value < 0.05. Adicionalmente se recomendaron análisis específicos para las dos variables que no fueron aceptadas. A partir del análisis estadístico se obtuvo una ecuación para medir el grado de madurez digital en Pymes manufactureras de Nuevo León que contribuye al avance en la transformación digital de las empresas manufactureras del estado.

Introduction

Industry 4.0 refers to the incorporation of new digital technologies into the value chain of organizations with a network of infrastructure, services, energies, factories and smart cities to generate innovative solutions for the benefit of humanity (Basco et al. 2018; Joyanes, 2020). This concept appeared in 2013 in Germany as part of the so-called Fourth Industrial Revolution.

In the organizational context, digital transformation is defined as an evolutionary process that leverages digital capabilities and technologies to enable business models, operational processes and customer experiences to create value in an organization (González Varona, 2021). The Covid-19 pandemic in 2020 triggered a forced digitalization making it necessary to use new technologies in favor of the survival of the companies.

Kane (2017) has used the degree of digital maturity to measure digital transformation in companies. This author defines digital maturity as the evolutionary stage in a continuous process of consistent adaptation to respond to digital transformation, as well as the achievements made by the organization in its transformation efforts.

Currently, in Mexico there is no national strategy to drive the necessary changes regarding technological advancement in organizations (Riquelme, 2019). ECLAC (Dini et al., 2021) confirms that the level of penetration of digital technologies in Latin America and the Caribbean has been profoundly uneven in its speed of adoption by sector.

A particular aspect in Mexico is that the economic sector of SMEs (small and medium-sized enterprises with less than 250 workers) dedicated to manufacturing, contribute almost 45% of GDP and generate 68% of jobs nationwide (INEGI, 2019). In Nuevo León, SMEs contribute 37.3% of the state's total economic income.

Given the above, digital transformation in SMEs is a key aspect to boost this important business sector in Mexico and Nuevo León. However, previous studies concerning the adoption of Industry 4.0, indicate that SMEs present higher barriers to implement new technologies due to their structure, availability of resources, financial, cultural, technical and legal aspects (Ghobakhloo and Ching, 2019; Horváth and Szabó, 2019).

In Mexico, there are exploratory studies related to technology integration in companies (Ynzunza, 2017; Perez and Lopez, 2019) and road maps (Gallegos, 2020). Specifically for Nuevo León, little literature was found regarding the factors that affect the digital maturity and technologies of SME organizations in the state of Nuevo León (Martínez, 2020).

According to previous studies, Nuevo León is one of the states in Mexico that shows the greatest progress in the process of technology integration and digital transformation, through important initiatives such as the so-called Nuevo León 4.0; however, in 2021, around 75% of companies in the state had not yet begun the transition to Industry 4.0, and only 5% of SMEs were participating in global value chains (Eunice, 2021).

Among the new technologies related to the advancement in digital transformation are: integration systems, robots, Internet of Things (IoT), additive manufacturing, big data analytics, the cloud, simulation in virtual environments, artificial intelligence, cybersecurity, augmented reality, blockchain, autonomous vehicles, cyber-physical systems, among other emerging technology applications. These new technologies are combined with new business models and organizational changes as organizations adapt to digital transformation (Basco et al., 2018).

There is significant research regarding the progress in digital transformation and adoption of Industry 4.0 in other regions of the world (Mittal, 2018; Ghobakhloo and Ching, 2019; Horváth and Szabo, 2019).

Souza et al. (2017) and Palos Sánchez et al. (2019) conducted a review of the most commonly used technology adoption models, and their combinations, having as most cited: 1) Davis' (1989) Technology Acceptance Model (TAM); 2) Tornatzky and Fleischer's (1990) Technology, Organization, and Environment (TOE) Framework; 3) Rogers' (1995) Diffusion of Innovations Theory (DOI).

According to Oliveira and Martins (2011), DOI and TOE are the only ones focused on organizations. The TOE framework (Tornatzky and Fleischer, 1990) was used in this research; it contains a solid theoretical basis and consistent empirical support that identifies three aspects of a firm's context that influence the process of adoption and implementation of technological innovation, which are the technological context, the organizational context and the environmental context (Oliveira and Martins, 2011).

Baker (2011) mentions that the technological context describes both internal and external technologies that are relevant to the organization, including internal practices and equipment, as well as technologies used outside the organization. Subsequently Dini et al. (2021) analyzed different levels of technologies found in the operations of companies in different Latin American countries.

Organizational context refers to descriptive measures such as focus, size of the company, individual, internal and external characteristics of the organization and its structure (Tornatzky and Fleischer, 1990). Several empirical studies demonstrate relationships between organizational factors (knowledge, managerial gender, size, capital and age of the firm, among others) and the use of technology (Zhu et al., 2003; Cuevas-Vargas, 2018)

The environment refers to the external environment in which the organization conducts its business, e.g., the industry, competitors, government policies (Tornatzky and Fleischer, 1990). Baker (2011) later includes the characteristics of the market or suppliers, the regulatory environment, intense competition that stimulates innovation adoption, and the influence of dominant firms in the value chain to initiate the adoption of innovations. Authors such as Rivas and Stumpo (2011) and Consoli (2012) analyzed the relevant elements of the environment that affect the appropriation of digital technologies in organizations.

Earlier Cohen and Levinthal (1990) introduced the concept of absorptive capacity as the ability of firms to acquire, assimilate and apply external knowledge for business purposes.

Zahra and George (2002) recognized knowledge absorptive capacity as a set of organizational processes through which firms acquire, assimilate, transform and exploit knowledge to compete in changing markets and capitalize on opportunities. Flatten et al. (2011) developed a validated tool to assess the dimensions of acquisition, assimilation, transformation and exploitation.

Pérez Hernández et al. (2019) provides empirical evidence in Mexico on the relationship of absorptive capacity and its influence on the generation and exploitation of technological knowledge.

According to the literature, another factor related to digital maturity is the capacity for innovation. Faced with such a concept, various authors provide elements for its understanding: the Oslo Manual (OECD/Eurostat, 2018) defines innovation as the implementation of significant changes in the product, process, marketing or organization of the company with the purpose of improving results. In Mexico, the National Council of

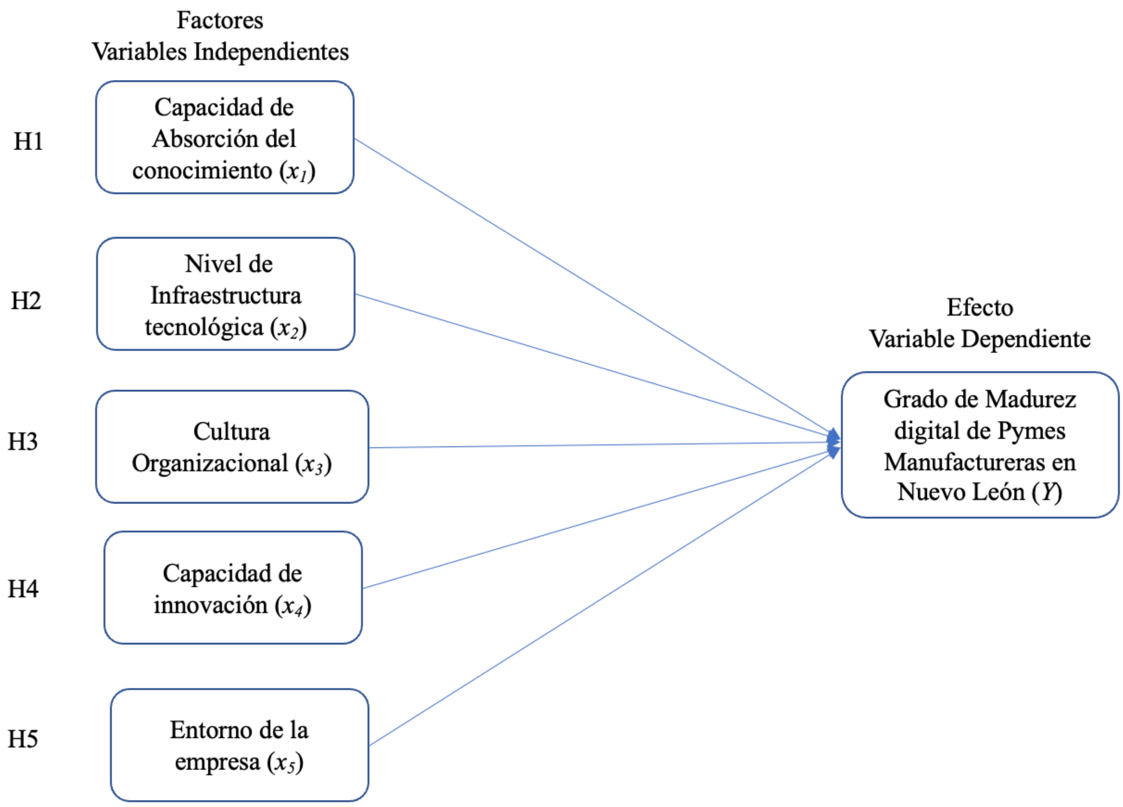
Science and Technology (CONACYT) defines innovation as the capacity to generate new products, processes, services, methods or to increase the value of existing ones.

Among the empirical studies related to factors related to innovativeness with digital transformation were found Breard and Yoguel (2013) and Zhu et al. (2003).

Based on the literature review and previous empirical research, this research analyzes the current situation of the degree of digital maturity in the region and the relationships found according to the most significant factors. Thus, the graphical model of the hypotheses shown in Figure 1 was constructed.

Figure 1

Graphical model of the hypotheses



Fuente: elaboración propia

The hypotheses presented in this research are as follows:

H_1: Knowledge absorption capacity is directly related to the digital maturity of manufacturing SMEs in Nuevo León.

H_2: The level of technological infrastructure is directly related to the digital maturity of manufacturing SMEs in Nuevo León.

H_3: Organizational culture has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León.

H_4: Innovation capacity is directly related to the digital maturity of manufacturing SMEs in Nuevo León.

H_5: The business environment has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León.

Method

The present research is quantitative because data collection was used in an objective manner to test the hypotheses generated through numerical measurement and statistical analysis of the variables considered. The type of design is cross-sectional because the measurement is performed at a single opportunity. The scope is exploratory by analyzing a topic little studied in the region, descriptive because the purpose is to investigate the incidence of the variables in the sample, explanatory correlational because it establishes the relationship of the variables based on the cause-effect relationship, it is non-experimental since the phenomenon was observed without performing any type of manipulation of the variables of the model (Hernández-Sampieri et al., (2018).

The sample was determined using the simple random probability sampling technique in a finite population of SMEs (small and medium-sized manufacturing companies) in the state of Nuevo Leon, at a 90% confidence level and a 10% error, resulting in the calculation of the sample in 66 participating subjects of SMEs manufacturing companies in the selected sample universe. The measurement instrument was developed based on studies cited in the literature review (Flatten, 2011; Kane, 2017; Rivas and Stumpo, 2013; Zhu, 2003; Consoli, 2012) and was sent to the selected companies with prior authorization from the surveyed subjects.

For data collection, a survey was applied with evaluation on a Likert scale from 1 to 5, type 1) Strongly disagree, 2) Disagree, 3) Neither agree nor disagree, 4) Agree, 5) Strongly agree, (Soriano, 2014). Through the evaluation of each survey item, a quantitative value was obtained for each variable, which was then used to analyze the results with the use of multiple linear regression. Table 1 shows the items, variables, classification, type and measurement of each variable.

Table 1
Variables, classification, type and measurement of study variables

Items	Variable	Variable Name	Ranking	Type	Measurement
CABC1 to CABC8	X1	Knowledge Absorption Capacity	Independent	Ordinal-discrete	Quantitative Likert Scale 1-5
NIT9 to NIT 19	X2	Technological Infrastructure Level	Independent	Ordinal-discrete	Quantitative Likert Scale 1-5
CO20 to CO27	X3	Organizational Culture	Independent	Ordinal-discrete	Quantitative Likert Scale 1-5
CI28 to CI35	X4	Innovation capacity	Independent	Ordinal-discrete	Quantitative Likert Scale 1-5
EE36 to EE43	X5	Company environment	Independent	Ordinal-discrete	Quantitative Likert Scale 1-5
MD44 to MD48	Y	Digital Maturity Level	Dependent	Ordinal-discrete	Quantitative Likert Scale 1-5

To determine content validity, the measurement instrument was submitted to a group of experts for review, resulting in the modification of the wording of some items and several recommendations regarding the scale used.

A pilot test was also conducted to check the reliability of the measurement instrument, in which the responses of 22 surveys from manufacturing SMEs located in Nuevo León were analyzed. Data analysis was performed using SPSS (Statistical Package for the Social Sciences) software. Cronbach's Alpha indicator was used for each variable to demonstrate the existing correlation. Table 2 shows the items eliminated in each variable and the items considered, in order to improve the internal consistency of the instrument. Finally, the survey was left with 41 questions for data collection.

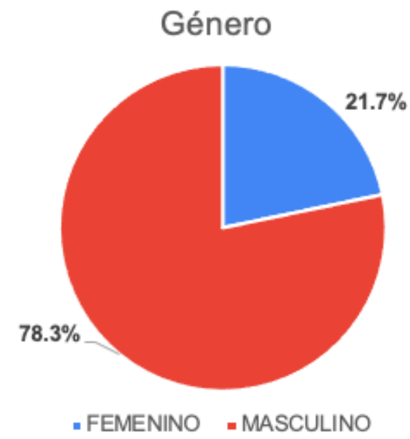
Table 2
Cronbach's Alpha values pilot test

Variable	Variable Name	Final Cronbach's Alpha	Items eliminated from the total	Items considered
X1	Knowledge Absorption Capacity	0.86	0/8	CABC1 to CABC8
X2	Technological Infrastructure Level	0.83	0/11	NIT9 to NIT19
X3	Organizational Culture	0.73	1/8	CO20, CO21, CO22, CO23, CO24, CO26, CO27
X4	Innovation capacity	0.85	1/7	CI28, CI29, CI30, CI31, CI32, CI33, CI35
X5	Company environment	0.77	3/8	EE38, EE39, EE40, EE41, EE42
Y	Maurez Digital Grade	0.72	2/5	MD44, MD46, MD48

Results

The results of the present investigation are shown below, presenting first some of the most important characteristics of the sample and then the results of the multiple linear regression for each variable. The number of surveys applied was 77, however, there were outliers in some of the samples, resulting in 69 surveys considered valid. This information is shown in Figure 2.

Figure 2
Gender of respondents



The descriptive statistics of the study items of the independent variable X1 Knowledge Absorption Capacity are detailed in Table 3, from which it is highlighted that the mean of the responses obtained tends to 3, an intermediate level of promoting and applying knowledge and training in new technologies.–The results of the CABC7 item average were 4, highlighting that employee education and training is fundamental for the improvement of the organizations in the companies surveyed.

Table 3
Descriptive Statistics of the Knowledge Absorption Ability Variable

	N	Minimum	Maximum	Media	Standard Deviation
CABC1	69	2	5	3.74	1.05
CABC2	69	1	5	3.62	0.99
CABC3	69	2	5	3.52	0.95
CABC4	69	2	5	4.00	0.91
CABC5	69	2	5	3.49	0.964
CABC6	69	1	5	2.94	1.29
CABC7	69	1	5	4.04	1.05
CABC8	69	1	5	3.81	1.13

In the case of the independent variable X2 Level of technological infrastructure, the descriptive statistical information is presented in Table 4, which shows that the average of the responses tends to be 2, indicating that there is knowledge of the technologies mentioned, but they are not used in the companies surveyed. It is interpreted in terms of the use of the technologies analyzed that the Cloud is the most used technology and Artificial Intelligence and Blockchain are the least used in the companies surveyed.

Table 4

Descriptive Statistics for the Variable Level of Technological Infrastructure

	N	Minimum	Maximum	Media	Standard Deviation
NIT9	69	1	5	3.16	1.02
NIT10	69	1	5	2.86	1.17
NIT11	69	1	5	2.52	0.95
NIT12	69	1	5	2.84	1.21
NIT13	69	1	5	2.02	0.91
NIT14	69	1	5	2.29	1.00
NIT15	69	1	5	2.35	1.19
NIT16	69	1	5	3.64	1.18
NIT17	69	1	5	1.90	0.79
NIT18	69	1	5	3.10	1.20
NIT19	69	1	5	1.62	0.97

In reference to the Organizational Culture variable, the information is presented in Table 5, it is observed that the average of each of the items is oriented towards 4, which refers to the importance that the surveyed organizations give to the organizational aspects in the company. In item CO27, the question refers to the importance of the leaders' vision in directing digitization efforts, which shows the greatest variation in the responses collected.

Table 5

Descriptive Statistics of the Organizational Culture Variable

	N	Minimum	Maximum	Media	Standard Deviation
CO20	69	2	5	4.33	0.83
CO21	69	2	5	4.45	0.80
CO22	69	1	5	3.87	1.04
CO23	69	1	5	3.78	1.11
CO24	69	1	5	4.13	0.97
CO26	69	1	5	3.48	1.16
CO27	69	1	5	3.74	1.16

Regarding the independent variable Innovation Capacity, an intermediate level is observed in terms of innovation aspects, new initiatives and research and development aspects in their organizations, since the average of the answers in all the items tends to be 3. Item CI33 refers to research for product or process improvement and shows greater variability without being significant. This can be seen in Table 6.

Table 6
Descriptive Statistics of the Innovation Capacity Variable

	N	Minimum	Maximum	Media	Standard Deviation
CI28	69	2	5	3.97	0.98
CI29	69	2	5	3.88	0.98
CI30	69	1	5	3.94	0.97
CI31	69	1	5	3.51	0.96
CI32	69	1	5	3.74	1.02
CI33	69	1	5	3.75	1.16

In the case of the independent variable Company Environment, a mean of 3 was obtained in 4 of the items that make up this variable, only in the case of item EE38 was a mean of 2.93, which inquires about the development of e-commerce or e-business in the value chain in its environment, also having the highest standard deviation of the items that make up the variable, with 1.10. This is shown in Table 7.

Table 7
Descriptive Statistics of the Company's Environment Variable

	N	Minimum	Maximum	Media	Standard Deviation
EE38	69	1	5	2.93	1.10
EE39	69	1	5	3.49	0.99
EE40	69	1	5	3.62	0.94
EE41	69	1	5	3.36	1.04
EE42	69	2	5	3.71	0.99

In the case of the dependent variable Digital Maturity, item MD44, which inquires about the company's digital transformation strategy being clear and coherent, an average tending to 3 is observed, with a standard deviation of 1.11, being the highest of the items that make up this variable, it is interpreted that the respondents do not have a clear and coherent perspective on the digital transformation strategies adopted by their organization. The other two items MD46 and MD48 show that the average respondent places their company at a beginner or learner level in terms of their level of digital maturity as shown in Table 8.

Table 8
Descriptive Statistics of the Company's Environment Variable

	N	Minimum	Maximum	Media	Standard Deviation
MD44	69	1	5	3.11	1.12
MD46	69	1	4	2.78	0.72
MD48	69	1	4	2.57	0.67

The results of the respondents show that the variables are between points 2 and 3 of the selected scale, indicating an intermediate level, beginner-learner in digital transformation, in terms of the constructs formulated in the survey.

Multiple linear regression results

The following section shows the results of the data analysis using multiple linear regression. In multiple linear regression the coefficients of the independent variables measure the absolute change resulting in the dependent variable in the face of the change in the independent variables (Hair et al., 2014). In this research, the effect of the five independent variables (X_1, X_2, X_3, X_4, X_5) on the dependent variable (Y) was evaluated using multiple linear regression modeling.

The model generated was tested against the principles of linear regression to check the correlation and significance of the variables and the hypotheses proposed.

Measure of goodness-of-fit: linear correlation coefficient

This test is used to determine the fit of data to a distribution in a population with a probability model. The R^2 statistic is used to indicate how close the data are to the fitted regression line. The R^2 indicates the percentage of variation in the response variable that is explained by a linear model. A value of 0 means that the model does not explain any percentage of the variability of the response data, i.e. there is no linear correlation, a result between 0 and 0.2 shows a very weak linear correlation, between 0.2 and 0.5 refers to a weak linear correlation, between 0.5 and 0.7 shows a medium linear correlation and between 0.7 and 0.9 is a strong linear correlation.

SPSS version 25 software was used for this research, first using the forced entry method and then the stepwise method, which generated 3 models shown in Table 9. According to the R^2measure, model 3 is the one with the highest validity, since an R^2 of 0.73 and an adjusted R-squared of 0.714 were obtained, as well as a strong linear correlation of 0.85 between the independent variables level of technological infrastructure, knowledge absorption capacity and company environment with the dependent variable digital maturity, which were included in the model. The variables excluded in this model were Organizational Culture and Innovation Capacity.

Table 9

Models developed by the method of successive steps.

Model	R	R square	R-square adjustment	Standard error of the estimate	*Durbin Watson*
1	0.744	0.553	0.55	0.64	
2	0.832	0.692	0.68	0.53	
3	0.852	0.726	0.71	0.51	*2.03*

Model 1	Independent Variables: Level of Technological Infrastructure (NIT)
Model 2	Independent Variables: Level of Technological Infrastructure (NIT), Knowledge Absorption Capacity (CABC)
Model 3	Independent Variables: Level of Technological Infrastructure (NIT), Knowledge Absorption Capacity (CABC), Enterprise Environment (EE) Dependent variable: Digital Maturity (DM)

Analysis of Variance: ANOVA

1. Analysis of Variance (ANOVA) is used to compare the variances between the means of two or more groups of data. In this analysis, Fisher's F equation from equation 1 was used, resulting in an F of 57.47, which is significant with a significant *p-value* of 0.00. This analysis is shown in Table 10. According to the results, the null hypothesis, which indicates that there are no interactions between the independent and dependent variables, is

rejected and the alternative hypothesis, which establishes that there is an interaction between the independent and dependent variables, is accepted, indicating that the model is significant.

Equation 1. Fisher's F Equation

$$F = \frac{FMS\ Regresión}{FMSResidual}$$

Fuente: (Montgomery, 2004)

Table 10

Analysis of Variance (Anova)

Model		Sum of Squares	DF	Quadratic Mean	F	Sig.
3	Regression	44.14	3	14.71	57.47	.00
	Waste	16.64	65	0.26		
	Total	60.78	58			
Model 3	Independent Variables: Level of Technological Infrastructure (NIT), Knowledge Absorption Capacity (CABC), Enterprise Environment (EE) Dependent variable: Digital Maturity (DM)					

Significance of the t-student variables

The t-student statistic was used to demonstrate which variables have an impact on the model. In this study, the stepwise method determined that 3 of the 5 variables entered in the model were significant. These variables are level of technological infrastructure (NIT), knowledge absorption capacity (CABC) and business environment (EE), all with positive impact. The standardized coefficients for the resulting model are shown in Table 11.

Table 11

t-student and standardized coefficients

Model Variable	Coefficients not Standardized		Standardized coefficients t	Coefficients	
	Beta	Standard error	Beta	t	Sig
Constant	-0.03	0.06		-0.41	0.68
Level of technological infrastructure	0.49	0.07	0.52	7.11	0.00
Knowledge absorption capacity	0.26	0.08	0.27	3.10	0.00
Company Environment	0.23	0.08	0.25	2.85	0.01

Linearity

This test is used to verify that the dependent variable and the independent variables have a linear relationship. The result of Pearson's correlation coefficient is analyzed according to the following parameters: coefficient of 1 indicates a perfect and positive relationship, between .90 $\leq r \geq 1.00$ is very high, .70 $\leq r \geq .90$ is high, .40 $\leq r \geq .70$ is moderate, .20 $\leq r \geq .40$ is low, r = 0 is null and r = -1.00 is large, perfect and negative.

Table 12 shows a high correlation for the variable level of technological infrastructure and a moderate correlation for the variables knowledge absorption capacity, company environment, organizational culture and innovation capacity; however, the stepwise method did not consider the variables organizational culture and innovation capacity in the proposed model.

Table 12
Pearson correlation

Type of Variable	Variable Name	Correlation
V.I	Level of Technological Infrastructure (NIT)	0.74
V.I	Knowledge Absorption Capacity (CABC)	0.66
V.I	Company environment	0.64
V.I	Organizational Culture	0.56
V.I	Innovation Capacity	0.56

Multicollinearity

This is a test to detect whether the independent variables of the linear regression present similarities, i.e. the existence of a strong correlation between them, so that the forecasts of the model obtained would not be reliable. The variance inflation factor (VIF) calculated in Equation 2 was used to demonstrate non-multicollinearity in the investigation. A VIF value must be below 10 to indicate that there is no multicollinearity. In practice, multicollinearity is considered to exist as from 5.

Equation 2. Multicollinearity calculation

$$VIF = \frac{1}{1 - R^2}$$

Table 13 below shows the statistical results that are within the ranges established by the literature.

Table 13
Multicollinearity

Model	Collinearity Variable	Tolerance	VIF
3	Constant		
	Level of Technological Infrastructure (NIT)	.78	1.28
	Knowledge Absorption Capacity (CABC)	.55	1.82
	Enterprise Environment (EE)	.56	1.79

A. Dependent Variable: Digital Maturity (DM)

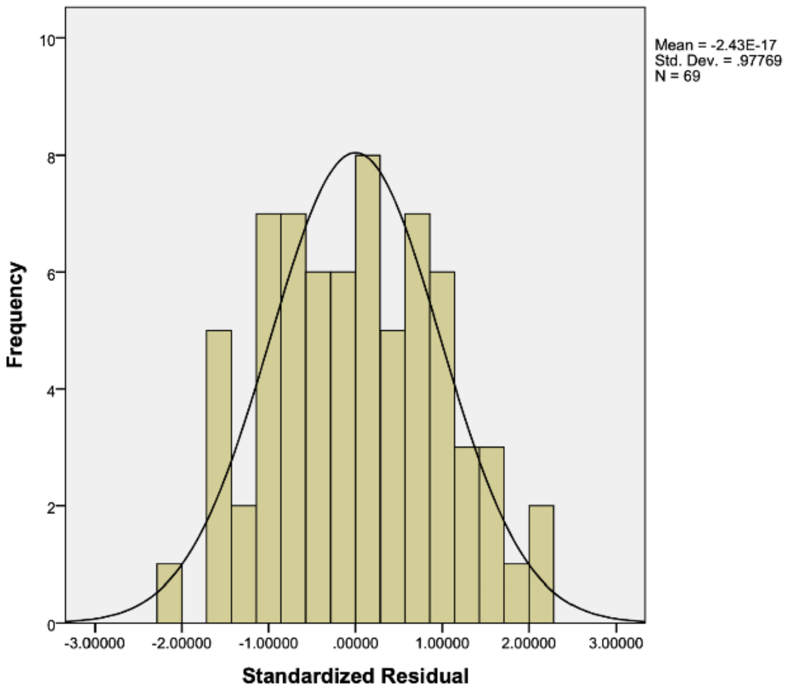
Durbin-Watson

The Durbin-Watson statistic is a test used to detect the presence of autocorrelation between residuals. The value of this statistic ranges from 0 to 4. The Durbin-Watson value should be at 2 or take allowed values between 1.5 and 2.5 to indicate that there is independence between the residuals. In this research the Durbin-Watson value is 2.03, indicating that there is no autocorrelation between the residuals.

Normality

Normality indicates that according to the results of the explanatory variables X, the dependent variable Y follows a normal distribution. To visually confirm normality, a histogram was generated showing that the data present a normal distribution with a slight asymmetry as shown in Figure 3.

Figure 3
Normality Graph



In addition, the Kolmogorov-Smirnov test was performed. In this test a result less than 0.05 indicates that the distribution is not normal, if it is greater than 0.05 the distribution is normal. A significance level of 0.99 was obtained for the data analyzed, concluding that the distribution is normal.

Hypothesis Testing

Table 14 shows the consolidated acceptance or non-acceptance of the hypotheses for the dependent variable Digital Maturity according to the statistical analysis performed.

Table 14
Consolidated Information of the Independent Variables

Variable	Hypothesis	Beta	P value	Accepted or Rejected
Knowledge Absorption Capacity	Knowledge Absorption Capacity is directly related to the digital maturity of manufacturing SMEs in Nuevo León	.26	.00	Accepted
Technological Infrastructure Level	The level of technological infrastructure is directly related to the digital maturity of manufacturing SMEs in Nuevo León	.49	.00	Accepted
Organizational Culture	Organizational culture has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León	-	-	Not accepted
Innovation Capacity	Innovation Capacity has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León	-	-	Not accepted
Company Environment	The business environment has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León	0.23	.00	Accepted

Given the above, equation 3 of the proposed multiple linear regression model is constructed, which when applied to a larger sample would explain 71.4% of the phenomenon studied.

Equation 3. Statistical model of the study

$$\Delta Y = -.03 + .26X_1 + .49X_2 + .23X_5 + \in$$

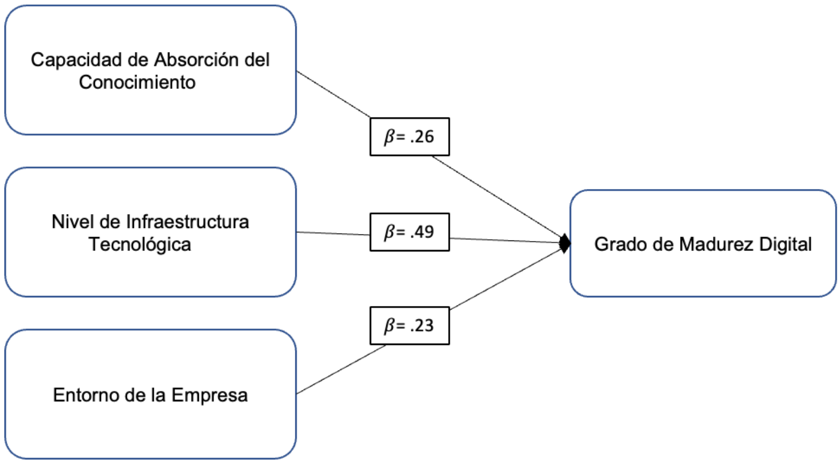
Where:
Y = Degree of Digital Maturity
X_1 = Knowledge absorption capacity
X_2 = Level of technological infrastructure
X_5 = Company environment

Discussion and Conclusions

The results indicated that of the five independent variables of the proposed model, three have a direct relationship with the dependent variable digital maturity in manufacturing SMEs in Nuevo León, which are knowledge absorption capacity, level of technological infrastructure and company environment.

On the other hand, the organizational culture and innovation capacity variables were not accepted because they were not significant according to the statistical method used. Figure 4 shows the results of the cause-effect model of digital maturity for manufacturing SMEs in the State of Nuevo León.

Figure 4
Final Cause-Effect Model



The statistical results obtained are consistent with the research of Zahra and George (2002) who recognize the capacity of knowledge absorption to acquire, assimilate, transform and exploit knowledge to generate change, improve organizational performance and maintain competitive advantages. Likewise, the research conducted coincides with the findings of Pérez Hernández et al. (2019), which indicates that knowledge absorption capacity is essential for the exploitation of technology, as well as the generation of new products or processes.

Regarding the level of technological infrastructure variable, the model developed coincides with Baker (2011) in indicating that it has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León. These results are consistent with the empirical study by Zhu et al. (2003), in which the use of technology is a driver in the adoption and transformation to a digital business.

Regarding the organizational culture variable, a direct relationship of this variable with digital maturity was not accepted, which contrasts with Kane (2017), who indicated the importance of changes in organizational culture and leadership in organizations to obtain a higher degree of digital transformation. The results also contrast with Tornatzky and Fleischer (1990), who established the importance of the organizational factor in technology adoption. It was considered that the result was due to the influence of the size of the company and the type of very flat structure where organizational leadership and decisions regarding the organization are centralized, i.e. generally taken by the owner or founders of the business and on whom depends the openness to new technological decisions, which affects the organizational culture of the company.

The Innovation Capacity variable was not significant in the adoption of new technologies. This result contrasts with several theories based on DOI or Diffusion of Innovations theory (Rogers, 1995; Oliveira and Martins, 2011). It is thought that the result in this study is due to the fact that, by participating in the survey, the owner or a senior manager of the company may have a bias in their answers, because they have a different view of what is happening in the innovation aspect compared to the employees of the company.

It should be noted that in the results of the two variables Organizational Culture and Innovation Capacity it was identified that the answers of some items are overvalued compared to other questions, which affects the final result. Regarding Organizational Culture, the items ask about the degree of importance of different aspects related to organizational culture, for example: how important is data analysis for decision making in your organization? When answering, the respondent may think that it is indeed important, but this does not mean that data analysis is applied for decision making, so it is recommended to restructure the wording of the questions in this section and change it to "How much does your organization apply data analysis for decision making?", in this way the answers would be closer to reality since the question is focused on the application of the tool.

Finally, the business environment has a direct relationship with the digital maturity of manufacturing SMEs in Nuevo León. The results are consistent with the contributions of various authors such as Dini (2021), who mentions the quality of the logistics infrastructure, the level of competitive pressure and the degree of digitalization of suppliers, Rivas and Stumpo (2011), who mention the economic environment, the productive sector, the legal and regulatory framework, the telecommunications and information technology infrastructure, and finally Consoli (2012), who points out factors such as customer innovation requirements and public policies, aspects that were questioned in the measurement instrument.

Limitations and recommendations

As for the limitations of the study, it was found that it was a difficult task to gather the responses of the participating companies, since the management levels generally have a very complicated agenda.

As future lines of research, it is recommended to improve the wording of the questions Organizational Culture and Innovation Capacity and to validate again the measurement instrument, since according to the literature these two variables are important for digital maturity in other regions in the world. It is also important to understand the impact of the size of the organization on the results, given that the analysis was conducted in SMEs, which show specific conditions different from large companies. On the other hand, a qualitative study is recommended in order to better understand in a descriptive manner the context of these two variables in manufacturing organizations in the state of Nuevo León.

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