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Classification of SMEs According to Their ICT Implementation

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Abstract. Small and medium enterprises (SMEs) are firms that have a wide impact on the country's economy in Colombia and contribute 28% of GDP, so it is essential to achieve the competitiveness of these organizations. The government has promoted plans to adopt information and communications technologies (ICT) at SMEs to increase their productivity and competitiveness. SMEs are organizations that lag behind in technology adoption. Several investigations have been carried out to characterize them, but no questions have been raised regarding the different types of SMEs that can be found according to their ICT implementation. This research aimed to determine the current usability and perception in the implementation of ICT and subsequently classify organizations based on these two factors. The results describe five types of SMEs: those that experience, those that have been negligent, those that lag behind, those that hesitate, and those that improvise. The data were collected in 2019, reflecting the state of SMEs before the lockdown due to the SARS-CoV-2 virus outbreak.

Keywords: ICT implementation; Small and medium-sized enterprises; SME competitiveness; SME innovation

1. Introduction

Technology has become fundamental support for SMEs (Hernández et al., 2017) to support the business model, generating greater efficiency and effectiveness of its management (Córdoba, 2015); the implementation of technological tools in SMEs is presented as a necessity to facilitate processes like operations or production and others to connect with consumers, generating impact and recognition, however, the needs of sophisticate ICT technology continues (Suryanegara et al., 2019). It is not enough to have skill and agility in management processes to achieve competitiveness (Qosasi et al., 2019); that is why it is necessary to develop new strategies to improve focus in the business area (Fonseca, 2013) understanding the concept of the digital economy as an innovative model, which generates social and economic impact, the result of the implementation of ICT (Katz, 2015).

In spite of the fact that SMEs bring economic growth to the nation, there are factors that hinder their development, such as the ignorance and fear of entrepreneurs to make an investment in ICT, although the National Competitiveness and Infrastructure Strategy

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proposed in 2014 granted 10% of royalties to the Science, Technology, and Innovation Fund (FCTI), a reform that sought to encourage production and research capacities (Private Council of Competitiveness, n.d.) The policies regarding ICTs set out in the plan "Vive Digital 2010–2014" (Ministry of ICT, 2011) to massify the use of technologies to guide the strategy are focused on the productive sector and end-user to increase the levels of competitiveness in each of the economic sectors and establish innovation as the main axis for the development of business initiatives (Cristancho et al., 2021).

Economic advances have been made in the countries that have invested in science, technology, and innovation activities (STIAs), reaching a high level in producing even more sophisticated goods and services (Novick et al., 2013). Despite the investment made in STIAs, the results remain low compared to other regions' countries, under 1% of GDP. The country has been focused on the development of increasingly demanding processes and activities, aiming to be competitive based on its business, mainly SMEs, a reason to implement IT in various sectors such as commercial, production, and logistics development, and allowing interconnection according to the demands of globalization (Puentes, 2017), despite the backwardness in innovation, to increase productivity (Private Council of Competitiveness, 2018).

The size should be relative to the performance sector (Montoya et al., 2010) due to the relevance of SMEs because, in addition to representing almost 100% of all firms, in countries of the Organization for Economic Cooperation and Development (OECD), SMEs generate more than half of the employment (OECD, 2002, cited by Blázquez-Santana et al., 2006). It achieves 35% of the GDP (Ministry of Labor and Social Security of the Government of Colombia, 2019). Nevertheless, it represents 3.86% in 2005 and 6.73% in 2019 of all enterprises (Table 1). SMEs face various obstacles: shortage of response to their needs in aspects of knowledge, skills, and capacity development in human capital, difficulty in accessing credit, and reducing the purchase and investment in ICT. Also, limitations in technology innovation advice and its applicability become barriers that hinder growth (Zevallos, 2006) and generate internal deficiencies (Zambrano-Alcívar, 2018).

Table 1 Number of establishments according to their size at the national level

Company Size	Number of Businesses in 2005	Share	Number of Businesses in 2019	Share
Micro business	1,336,051	96.01%	1,504,329	92.8%
Small	46,200	3.3%	87,761	5.41%
Medium	7,447	0.53%	21,459	1.32%
Big company	1,844	0.13%	6,793	0.4%
Total	1,391,542		1,620,342	100%

Note: Prepared from DANE (2005) and Applied Economics (2019).

For SMEs, the biggest barrier is the costs that imply ICT, as well as the financing to achieve greater technological investment and the adaptation of technology in systems and processes that meet the needs. Financing and adaptation represent a medium incidence and, to a lesser extent, the availability of information and the supply of services (Rodríguez, 2003); also, the human capital gap is a complex problem due to (1) the limited production of graduates in STEM areas and (2) the lack of critical mass in capacities necessary to work on digital innovation (Katz, 2015).

What digital transformation brings to businesses is the ability to reach their customers, monitor their workforce, and reach out to their suppliers anytime; this allows automation, standardization, and control, management, performance, productivity per worker (Confecámaras, 2018; Shoushtary, 2013) and, enhance the satisfaction of their customers (Berawi, et al., 2020), but ACOPI (2017) argues that SMEs requires greater integration into

global information networks and value chains because the impact of the digitization of production processes and the level of productivity of the countries is not linear and depends on variables such as quality of human capital, innovative capacity, and organizational changes (Cimoli et al, 2009; Balboni et al, 201).

The implementation of ICTs must involve training, given that the economy forces organizations to be changing permanently to respond to new demands (Cardona-Mejia, 2018). To be profitable, an organization must innovate (Freel, 2005), thereby achieving product improvement and cost reduction, profit increase, and market share expansion (Heredia, 2010). In this way, technology generates changes both inside and outside the organizations.

Although the accelerated technological advance supposes business growth, SMEs are those types of organizations that present more lag and, given their contribution to the economy, it is necessary to inquire about the current uses and the perception of the implementation of ICT in these SMEs and comprehend the different states in which SMEs could be classified based on the two factors mentioned. Technological trends related to mobile apps, security or data protection in information, cloud computing, big data, and business intelligence are presented. These are an opportunity to access ICT at a lower cost compared to on-site technologies (Marston, 2011). This applies to many practices, including customer management and organizational planning (Gálvez et al., 2014).

In 2010, micro-enterprises increased their use of the internet by 20% (Ortega, 2014); however, Weiss (2010) indicates that the perspective is regrettable considering the different factors that influence the current era, that technology represents daily life, and that development of systems focused on the needs of users is becoming faster.

The growth of the different technologies and the constant evolution of the market show the scarcity of resources SMEs have, but not without adequate monitoring of the use and management practices of these tools (Jones et al., 2016). This perspective suggests to SMEs a deep knowledge of the type and quality of investment to be made in ICT for organizational growth and development. The use and appropriation of ICT of these tools allow directing processes, training human capital, and managing information, communication, and innovation (Marulanda & López, 2013), for which all sectors are interested today (Méndez et al., 2017) to be able to strengthen global, regional, and local strategies that allow development and growth within the market to increase an organization's competitiveness.

2. Methods

The methodology was supported by a cross-sectional descriptive study in which the collected data were analyzed (Hernández-Sampieri & Torres, 2018) to obtain the information concerning the behavior of SMEs prior to the outbreak of SARS-CoV-2. A quali-quantitative approach was established through variables that allowed showing the use of information technologies in SMEs, as well as the experiences that reflected situations of ICT appropriation to identify the factors that described the relationship of SMEs with IT and their experience of use and appropriation. Firms in the service sector registered in the Chamber of Commerce of Bogotá in 2019 corresponded to 764,639 businesses; much interest was put on SMEs with a payroll between 11 and 200 people according to the classification indicated in Law 905 (2004), which classified enterprises having between 11 and 50 employees as small and those having between 51 and 200 employees as medium.

A total of 307 enterprises were selected with a confidence limit of 90% and ±4.7% error. Through simple probabilistic selection, data were collected between April and June 2019, and face-to-face meetings were held to answer the questionnaire.

3. Results and Discussion

The data collected were processed according to the hierarchical cluster analysis procedure to identify groups of membership according to the similarities that might occur, as they had a very close distance between the groups to characterize each of the selected clusters.

The cluster distribution was carried out using the Ward method and re-scaled distance, which allowed selection of five groups of firms that had homogeneous characteristics among themselves.

Table 2 Mean comparison of each cluster

Cluster	TI	SL1	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	4.71	6.26	10.42	1.22	1.9	0.27	0.38	0.13	0	0	0.23	0.9
2	4.62	4.62	8.28	1.36	2.26	0.04	0.34	0.58	0	0	0.16	0.18
3	4.05	3.5	6.82	1.39	0.61	0.34	0.21	0.08	0.05	0.05	0.21	0.37
4	4.33	4.35	6.36	1.08	0.73	0.04	0.26	0.1	0	0	0.21	0.1
5	5.6	6.47	73.53	10.5	15.07	1.4	6.4	4.73	0.27	1.2	6.27	5.13
Total	4.55	5.09	11.77	1.72	2.16	0.23	0.63	0.44	0.02	0.07	0.52	0.71

Cluster	F1	F2	F3	F4	F5	F6	F7	F8	F8.	QE
1	3.73	3.76	2.7	2.07	3.36	2.97	2.56	1.63	1.34	44.72
2	3.34	3.62	1.72	1.48	2.78	1.74	1.34	1.02	0.4	28.64
3	1.61	2.18	0.87	0.82	1.21	1.5	0.95	0.5	0.24	19.05
4	2.82	2.96	0.86	1.1	2.04	1.45	1.35	0.78	0.4	26.28
5	3.73	4	2.67	2.13	2.93	2.07	3.73	3.07	1.87	140
Total	3.13	3.32	1.78	1.54	2.59	2.1	1.86	1.22	0.8	38.47

Cluster	I1	I2	I3	I4	I5	I6	I7	I8	I9
1	4.81	4.2	4.58	4.73	2.85	4.23	3.85	2.97	4.26
2	4.58	3.82	4.16	3.8	1.34	3.18	3.1	1.72	3.68
3	2.32	1.32	1.39	2.39	0.32	1.79	0.89	0.39	1.16
4	4.17	3.47	3.76	4.08	2.19	2.94	2.83	2.36	2.83
5	4.87	4.27	4.33	4.6	2	3.47	4.07	3.27	4.47
Total	4.27	3.56	3.85	4.07	2.02	3.33	3.06	2.26	3.37

Cluster	L1	L2	L3	L4	L5	L5	L6	L7	L8	L9	S1	S2
1	4.76	4.05	4.41	4.63	2.62	3.97	3.69	2.96	4.17	2.7	6.14	2.79
2	4.52	3.9	4.04	3.62	0.8	2.74	2.78	1.38	3.3	1.52	3.86	1.34
3	1.95	1.05	0.87	1.24	0.66	0.82	0.53	0.55	0.61	0.63	1.76	1.66
4	3.27	2.68	3.18	3.09	1.67	2.06	1.73	1.46	2	1.08	3.13	1.33
5	4.8	3.87	4.13	4.2	1.4	3.4	3.8	2.8	4.4	3.27	8.33	3.33
Total	3.94	3.24	3.52	3.56	1.72	2.79	2.58	1.95	2.97	1.8	4.45	2.02

Cluster	S3	TR	II1	II2	II3	II4	II5	II6	II7	II8	S4	S5	AI
1	3.53	1.5	2.21	2.12	2.1	2.26	2.18	2.14	2.31	2.5	10.33	8.71	2.64
2	3	1.38	0.1	0.14	0.22	0.16	0.26	0.14	0.14	0.16	6.34	7.12	2.28
3	2.58	1.21	1.32	1.18	1.16	1	0.82	2.32	1	0.74	3.5	4.63	2.47
4	2.74	1.68	2.44	2.22	3.06	2.95	2.79	2.82	3.12	2.83	5.58	7.99	2.82
5	3.47	1.67	1.2	1.07	1.73	1.27	1.4	1.4	1.53	1.13	11.6	10.33	2.93
Total	3.09	1.5	1.73	1.62	1.89	1.86	1.79	1.96	1.94	1.87	7.5	7.78	2.62

Note: The description of variables is shown in Table 4. A comparison of the means of the five groups identified for the study variables was performed. Source: Prepared by the authors.

Cluster 1: 36.7% of the participating firms belong to this group. These organizations (Table 2) have been in business for a longer time, with a level of departmentalization greater than the average; they make more frequent use of devices in the areas of general management, human resources, accounting, marketing, and sales. It is the group where government transactions, customer service, online distribution, advertising, and marketing

activities are given the greatest importance. It is the group that places the highest importance on government transactions, customer service, online distribution, and advertising and marketing. It is the group with the largest implementation of email, electronic banking, government transactions, customer service, online distribution, advertising and marketing, and government information search; finally, it is the group that indicates that its employees have the highest number of technological skills.

Cluster 2: 17.5% of the participating organizations belong to this group. It is the group of firms that have, (table 2) on average, the least number of tablets and capture devices. This group is characterized by having the lowest level of perception of the importance of low financial resources, difficulty in accessing credit, state support in training, qualified personnel, infrastructure, national coverage and connectivity, business infrastructure, and ignorance of resources and technologies in the implementation of ICTs.

Cluster 3: 13.3% of the participating businesses belong to this group, corresponding to organizations (table 2) between 5 and 10 years of existence in the market, with less degree of departmentalization; in this group, there is the lowest average number of smartphones, smart TVs, audio players, and e-readers. In this cluster, there is less use frequency of devices in the general direction, in the administrative direction, and in the areas of production, accounting, computer support, quality, and environmental management. It is characterized by a lower level of importance to the use of email, personal banking, government transactions, customer service, online distribution, advertising and marketing, research and development, search for government information, and management of business processes; at the same time, it is the group of firms with the least implementation of email, electronic banking, government transactions, customer service, online distribution, advertising and marketing, research and development, search for government information, internal processes, and technological tools. Employees have fewer technological skills and a lower degree of knowledge in the implementation of computer security measures.

Cluster 4: 27.3% of the participating firms belong to this group. It is the group of organizations that have the lowest average (table 2) number of PCs, laptops, and tablets in the organization and the least radio communications equipment. They also indicate having the lowest frequency of use of devices in the human resources area and in the market area and the least implementation of social networks. They tend to do more training in ICTs and are the group of organizations that perceive a greater importance of low financial resources, difficulty in accessing credit, state support in training, qualified personnel, infrastructure, national coverage and connectivity, business infrastructure, and lack of knowledge of resources and technologies in the implementation of ICTs.

Cluster 5: 5.2% of the participating enterprises belong to this group. In this group (table 2) firms have the longest operating time in the market with more than 20 years, have the highest level of departmentalization, and have the largest number of electronic devices; they are also organizations where electronic devices are used more frequently in general, administrative, production, IT support, quality department, and environmental management. It is the group where email, electronic banking, research and development, government information, and company process management are given greater importance. In turn, this group shows a higher level of implementation of information search for research and development, management of internal processes, computer networks, technological tools, and social media, and they stand out for a greater degree of implementation of security measures and greater investment in ICT.

Table 3 Kaiser–Meyer–Olkin and Bartlett test

Kaiser–Meyer–Olkin measure of sampling adequacy		0.779
Bartlett's test of sphericity	Approx. Chi-squared	8907.62
	gl	1540
	Sig.	0.000

According to the Kaiser–Meyer–Olkin test (Table 3), the model is acepted (KMO 0.779) and has a significant P-value <0.05 according to Bartlett's sphericity test.

Table 4 Rotated component matrix*

	Factors	
	1	2
L8 Implementation level of internal process management in enterprise	0.687	−0.055
L6 Implementation level of information search to development and research in enterprise	0.658	−0.036
I3 Governmental transaction service utilization importance level to enterprise	0.648	−0.073
L1 Implementation level of email in enterprise	0.626	−0.028
L9 Implementation level of Informatic net in enterprise	0.624	−0.127
L5 Implementation level of marketing and advertisement in enterprise	0.622	0.059
	0.613	−0.017
	0.611	−0.121
L3 Implementation level of government transaction services in enterprise	0.611	0.014
I7 Development and research internet information utilization importance level to enterprise	0.604	0.048
I1 Email utilization importance level to enterprise	0.603	−0.114
L7 Implementation level of government search information enterprise	0.603	0.136
I2 E-banking and financial services utilization importance level to enterprise	0.601	−0.082
S1 Degree of implementation of technological tools	0.596	−0.169
L2 Implementation level of e-banking and financial services in enterprise	0.588	−0.098
F5 Frequency of uses of electronic devices in accountability and financial management	0.553	−0.172
I8 Governmental information search utilization importance level to enterprise	0.548	0.227
S4 Degree of implementation of security arrangements	0.54	−0.025
L4 Implementation level of customer service in enterprise	0.537	0.113
I6 Marketing and advertisement utilization importance level to enterprise	0.521	0.035
F1 Frequency of uses of electronic devices in general management	0.493	−0.126
F3 Frequency of uses of electronic devices in human resources	0.486	−0.229
F7 Frequency of uses of electronic devices in IT support	0.474	−0.12
I5 Online product delivery utilization importance level to enterprise	0.467	0.239
F2 Frequency of uses of electronic devices in administrative management	0.462	−0.172
I4 Customer service utilization importance level to enterprise	0.446	0.095
L5 Implementation level of online product delivery in enterprise	0.441	0.227
F2 Frequency of uses of electronic devices in environmental management	0.408	0.01
QE Quantity of employees that use internet	0.407	−0.172
F8 Frequency of uses of electronic devices in quality management	0.39	−0.075
F6 Frequency of uses of electronic devices in marketing and sales	0.378	−0.015
S3 Degree of technological skills of human resources	0.365	−0.19
S2 Degree of implementation of social media	0.36	−0.081
F4 Frequency of uses of electronic devices in production department	0.352	−0.059
S5 Degree of knowledge concerning security arrangements	0.299	0.02
Q1 Quantity of PCs	0.29	−0.197
Q3Quantity of smartphones	0.251	−0.2
Q10 Quantity of radios	0.206	−0.07
TI Business uptime	0.156	−0.132
Q9 Quantity of information capture devices	0.146	0.023
Q4 Quantity of tablets	0.131	−0.077
A1 Annual investment in ICT	0.119	−0.087
II8 Importance of ignorance of resources for ICT implementation	0.098	0.813
II4 Importance of qualified personnel in the implementation of ICTs	0.083	0.811
II2 Importance of difficult access to financial credits in the implementation of ICTs	0.022	0.81
II5 Importance of infrastructure, coverage, and connectivity in the implementation of ICTs	0.102	0.791
II7 Importance of technological ignorance for the implementation of ICTs	0.177	0.791
II1 Importance of low financial resources in the implementation of ICTs	0.02	0.781

II3 Importance of state support in ICT training	0.042	0.75
II6 Importance of business infrastructure in the implementation of ICTs	−0.078	0.408
Q8 Quantity of e-reader or kindle	0.171	−0.182
Q2 Quantity of laptops	0.174	−0.18
Q5 Quantity of smart TV	0.124	−0.149
Q7Quantity of video game consoles	0.075	−0.136
Q6 Quantity of audio and video player	0.071	−0.125
TR Training	0.068	0.08

Note: Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization.
* The rotation has converged in three iterations. Source: Prepared by the authors.

Given the variety of variables studied of the participating firms, a reduction of factors was developed through principal component analysis techniques. This process allowed reducing the complexity of the data (López-Roldán & Fachelli, 2015) to two factors called implementation ICT index and perception of implementation ICT importance (Table 4).

The identified components allowed the visual representation of each case studied and classified with respect to its membership cluster in a scatter graph (Figure 1). From this, the behavior of each cluster is observed in relation to two data reduction components.

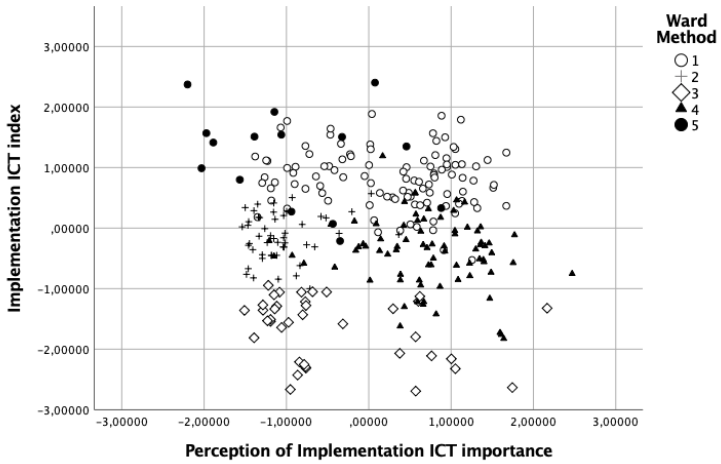

Figure 1 Scatter graph for each cluster

In the case of cluster 1, there is a group of firms that tend to implement technological resources and that in turn do not have a defined position regarding the importance of ICT implementation (Figure 1). In contrast, cluster 2 presents a low rate of implementation of ICTs, and at the same time, it shows little importance of the implementation of ICT. Cluster 3 corresponds to a group of firms that have the lowest rate of ICT implementation, although it does not have a specific position regarding the importance of ICT implementation. On the other hand, cluster 4 tends to concentrate on average implementation levels with respect to the sample, and it tends to have a higher level of perception regarding the importance of implementing ICT. Cluster 5 represents organizations that have the highest rate of ICT implementation but at the same time have a lower perception regarding the importance of ICT implementation.

4. Conclusions

It shows great differences between service SMEs in the use of ICT, which reflects that the sector is not competitive, the government's actions have not been effective in spreading the use of technology, and, finally, there is scarcity of knowledge on the part of the entrepreneur to take advantage of the available and accessible technology.

Micro-business and SME-type firms represent a great contribution to the Colombian economy, with more than 90% of the national productive sector, contributing 35% of GDP and generating 80% of employment (Ministry of Labor and Social Security of the Government of Colombia, 2019), but only SMEs contribute 28% of GDP, 67% of employment, and 37% of national production (Hoyos-Estrada & Sastoque-Gómez, 2020). The findings have allowed us to establish five groups of firms delimited by the use of technological tools, departmentalization, and perception of how critical it is to implement ICTs in the organization.

Cluster 1 (36.7%) has defining as the business that experiments in the use and implementation of ICTs, tend to turn out more complex in their departmentalization, and has more technological implementation in key areas, but they do not show complete comprehension of the importance of implementing ICTs. Cluster 4 (27.3%) is defined as those organizations that are negligent with the implementation of ICTs, the firms in this class are aware of the importance of ICTs but have not acted to a greater degree of implementation of ICTs. This cluster 2 (17.5%) is named firms that hesitate in the use and implementation of ICTs, due having a lower perception of how critical it is to implement ICTs in the organization; and Cluster 3(13.3%) has defining as the organizations lagging behind in the use and implementation of ICTs, corresponds to young firms, with the least degree of departmentalization and less use of ICTs and their employees have lower rates of knowledge in ICTs, as well as a lower frequency in the use of electronic equipment. Cluster 5 (5.2%) as firms that improvise in the use and implementation of ICT, which has, on average around 20 years in market. They have a greater departmentalization and use technological tools more frequently, despite having a low perception of the importance of implementing ICT.

To advance future research, it is suggested to inquire about the gap between service SMEs that implement ICT and those that do not to expose the factors that enable or limit the acquisition and use of ICT. Moreover, the data presented contextualize the ICT implementation prior to the start of the pandemic period, and because it has accelerated entrepreneurship, innovation, and digitization (Gavrila & de Lucas, 2021), it is convenient to reflect the changes adopted during the current scenario.

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