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# Critical Factors for ICT Adoption in Industrial Sector Micro and Small Enterprises (MSEs)

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**ABSTRACT**

Micro and small-sized enterprises (MSEs) employ approximately 60% of the economically active population (EAP) in our country, but only 15% of them have access to information and communication technologies (ICTs). Therefore, it is believed that these companies do not understand ICTs, do not value them or give them due importance and are reluctant to adopt and use ICTs. This non-experimental research aims to find evidence of the relationship between critical factors and the adoption of information technologies in this type of company. To this end, a survey was conducted among 179 businessmen in Metropolitan Lima. Following the evaluation and analysis of the data obtained, it was found that 11 factors have a positive correlation for the adoption of information technologies and 3 are rejected because the significance level obtained is greater than 0.05. Thus, a new model of ICT adoption based on the 11 accepted factors is created for this type of company.

**Keywords:** MSE; ICT; TOE; technology adoption; manufacturing industry.

## INTRODUCTION

At present, all organizations (large and small) are facing significant situations: new management trends, use of technological tools, more advanced software, multichannel and omnichannel marketing, etc. However, it is observed that, in particular, micro and small-sized enterprises (MSEs) do not embrace and do not use ICT tools, which prevents them from leveraging potential growth opportunities. In its publication Encuesta Económica Anual 2018, the Instituto Nacional de Estadística e Informática (INEI) reveals that 97.7% of the manufacturing industry uses computers for their daily activities and 91.8% of MSEs use the internet. Also, 59.2% of companies use e-mail and chat as the main technological tool to communicate with their staff, customers and suppliers (INEI, 2020).

Further research is needed to identify the critical factors or determinants that limit the adoption of ICTs in industrial MSEs in Metropolitan Lima. Numerous research studies related to the adoption of information technologies in the last five years have referred to the benefits of ICTs and a variety of critical factors that influence their adoption.

Cuevas-Vargas, Estrada, and Larios-Gomez (2016) argued that ICT contributes to improving economies, generating growth and efficiency, and facilitating digital transformation through process improvements and automation. Hassan (2017) studied the effect of organizational factors on cloud computing adoption among small and medium-sized enterprises (SMEs) in the service sector in Malaysia. The results obtained in her study indicated that critical factor IT resources had a significant influence on cloud computing adoption; however, critical factors such as senior management support and employee knowledge were not significant.

Singh, Luthra, Mangla, and Uniyal (2019), on the other hand, conducted a study of SMEs in the food sector, in which they pro-

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posed 17 critical factors for technology adoption. They found that organizations in the food sector were trying to use ICT to restructure value chain activities with the aim of reducing waste, improving resource utilization, and protecting the environment.

Chau and Deng (2018) developed a conceptual framework that allows researchers to empirically test and understand the critical factors for m-commerce adoption in Vietnamese SMEs. This model allows assessing critical factors such as perceived benefits, perceived compatibility, perceived complexity, perceived security, perceived security, perceived costs, employees' IT knowledge, organizational readiness, strategic orientation, top management support, competitive pressure, customer pressure, and government support. In Vietnam, mobile devices are the most popular means of Internet connection, accounting for 98% of all devices used for accessing the Internet. However, the slow adoption of m-commerce in Vietnamese SMEs can be attributed to many challenges. First of all, Vietnamese SMEs share the same barriers to the adoption of new technologies in general and m-commerce in particular as SMEs in other developing countries. (Chau & Deng, 2018, p. 435)

Presently, many MSEs have been forced to shut down their operations as a result of the COVID-19 pandemic, as they lack the technology to operate online. Social networks have been flooded with offers of goods and services with a strong digital management component. Micro and small-sized enterprises have had to adopt this form of customer service that is new to them, as previously they had no interest in doing so. This research attempts to identify the critical factors that prevented them from adopting this way of working.

It has two objectives. First, to propose a coherent conceptual model that includes the most relevant critical factors for the success of ICT adoption, and second, to test the proposed model by collecting quantitative data based on its critical attributes.

The general hypothesis states that "There is a relationship between the proposed model and ICT adoption in industrial MSEs in Metropolitan Lima".

There are some limitations to this study, as it focuses on the development and review stage of the conceptual model; therefore, an experimental study should be conducted at a later stage to test the proposal and corroborate the results.

Due to the limitations of the research on the adoption of ICTs in MSEs, the specific critical factors in the proposed model for ICT adoption were identified using a qualitative approach. The study population consisted of MSEs that had not adopted ICTs in Zone 4, the La Victoria district of Metropolitan Lima, according to the APEIM NSE 2020 classification. Differences in their perception of the critical factors may create bias for the empirical results. Finally, the proposed framework was developed for the case of SMEs located in Metropolitan Lima that have not yet adopted an IT system.

A comprehensive model is proposed to summarize the main contributions of previous studies, which have identified the critical factors for the adoption of ICTs in industrial MSEs in Metropolitan Lima. The theoretical basis of technology adoption at the organizational level describes how the enterprise's specific context influences the adoption and implementation of technology.

Numerous empirical studies have analyzed the critical success attributes (CSA) for ICT adoption. An exhaustive review of the relevant literature was conducted for this study in an effort to gain a comprehensive view of the topic and, consequently, better define its scope. A breakdown of the factors from the literature reviewed is presented in Table 1.

The proposed model is shown in Figure 1.

This research contributes to strengthen the knowledge of the critical factors for the adoption of ICTs in MSEs and helps managers to better assess the condition of the enterprise and the possible critical factors that would lead to the successful adoption of ICTs in their enterprises.

## METHODOLOGY

As per the classification of Hernández (2014), this is a descriptive-correlational study. It is descriptive because the properties and characteristics of people are specified and subjected to analysis, and correlational because the degree of relationship that exists between two or more variables is calculated. A non-experimental, cross-sectional, correlational-causal design is used, since the variables are not deliberately modified, events are only observed and analyzed in their natural environment to describe the variables assessed on correlational terms.

The unit of analysis of the research is comprised of owners, managers, bosses or employees with work experience in a micro, small or medium-sized industrial enterprise in Metropolitan Lima.

**Table 1.** *Critical Attributes Identified.*

| Factors | CSA | Literary Reference |
|---|---|---|
| ***Technological*** | **Perceived benefits** | (Oliveira & Martins, 2010), (Chau & Deng, 2018) |
| | **Perceived complexity** | (Rogers & Shoemaker, 1971), (Thong, 1999), (Chau & Deng, 2018) |
| | **Perceived security** | (Sulaiman, 2000), |
| | **Perceived cost** | (Thong, 1999), (Chang, Hung, Yen, & Lee, 2010), (Tornatzky & Fleischer, 1990) |
| ***Organizational*** | **Technology readiness** | (Rahayua & Daya, 2015), (Zhu, Kraemer, & Xu, 2006), |
| | **Previous technological experience** | (Rauta, Gardas, Jhac, & Priyadarshinee, 2017) |
| | **Resistance to change** | (Luiz, Costa, Dos Santos, & Tutsumi, 2020) |
| | **Organizational culture** | (Chiavenato, 2002) , (Gibson, Ivancevich, Donelly, & Konospake, 2006) |
| ***Contextual or Environmental*** | **Pressure from suppliers** | (Rahayu & Day, 2015), (Duan, Deng, & Corbitt, 2012) |
| | **Pressure from competitors** | (Zhu & Kenneth, 2005) |
| | **Government support** | (Rauta, Gardas, Jha, & Priyadarshinee, 2017), (Alrawabdeh, 2014) |
| ***Individual*** | **Senior Management commitment** | (Thong, 1999), (Rauta, Gardas, Jha, & Priyadarshinee, 2017), (Gangwar, Date, & Ramaswamy, 2015) |
| | **Managers' attitude towards IT adoption** | (Chang, Hung, Yen, & Lee, 2010), (Chen, Windasari, & Pai, 2013) |
| | **Management ICT experience** | (Rahayu & Day, 2015), (Morteza, Arias-Aranda, & Benitez-Amado, 2011) |

Source: Prepared by the author.

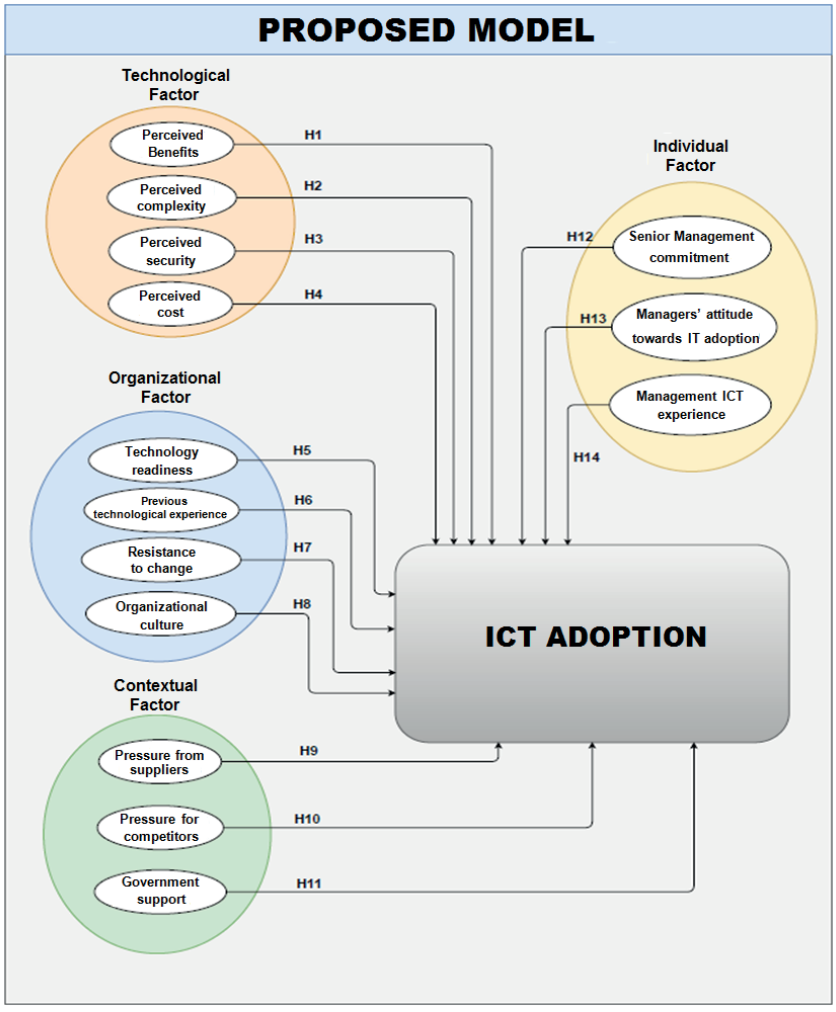


***Figure 1.*** Proposed model.
Source: Adapted from Tornatzky and Fleischer (1990).

The data collection instrument is the survey and the results will be processed with the statistical program SPSS version 25.0 for Windows and Excel 2019 to process the tables.

Figure 2 shows the polynomial population. It shows the number of industrial enterprises in Metropolitan Lima which totals 99 477, of which 92 369 are micro enterprises and 7 108 are medium-sized enterprises.

Based on the 99,477 companies identified, a segmentation was applied using as a reference the industrial enterprises in Zone 4, district of La Victoria, according to the APEIM NSE 2020 classification, that had not adopted ICTs. The population consisted of 186 MSEs. A pilot survey of a group of 67 respondents was used to calculate the standard deviation (σ), which yielded a pessimistic result of 1.71, a margin of error of 5% and a confidence level of 95%.

The parameters used to calculate the sample are presented in Table 2:

**Table 2.** *Parameters for Sample Calculation.*

| Description | Variable | Value |
|---|---|---|
| Population size | N | 186 |
| Confidence level | Z | 1.96 |
| Standard deviation | σ | 1.71 |
| Estimation error | e | 0.05 |

Source: Prepared by the author.

Sample size calculation formula:

$$\frac{NZ^2\sigma^2}{e^2(N-1)+Z^2\sigma^2}$$

There were 179 individuals in the sample.

A pilot survey was used to test the reliability of the instrument. Initially, 67 questions were selected for the instrument and statistical indicators were evaluated to validate and adjust the final instrument. The initial survey was conducted online in March 2020 using these questions. Initially, the survey was to be carried out in a mixed form, i.e. in-person and online, in the main industrial production centers of Metropolitan Lima that had not adopted ICTs and belong to Zone 4 - district of La Victoria. For this purpose, a team of 10 people was formed, including the researcher; however, the in-person survey had to be discarded, due to the 2020 pandemic.

Out of 36 questionnaires completed in the pilot survey, only 28 were valid. Cronbach's alpha was then calculated and 13 questions were eliminated because they did not reach the expected value. Finally, 54 questions were selected to evaluate the adoption of ICTs in industrial MSEs in Metropolitan Lima and, additionally, 8 general questions.

Table 3 shows the reliability results for the instrument obtained using Cronbach's alpha coefficient.

Fifty-four questions were considered for the final survey instrument after eliminating 13 questions from the initial questionnaire; the final items obtained the expected Cronbach's alpha coefficient.

**Variables**

Independent: Critical success factors

Dependent: Adoption of information technologies in industrial micro and small-sized enterprises

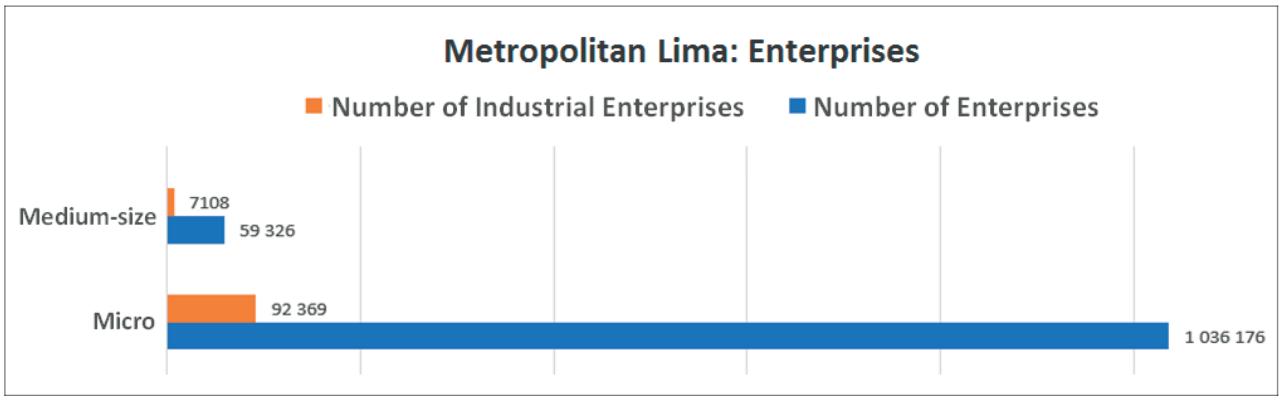


***Figure 2.*** Study population.
Source: Prepared by the author.

**Table 3.** *Reliability of the Instrument.*

| CSA | Initial Cronbach's alpha | Final Cronbach's Alpha | No. of initial items | No. of deleted items | No. of final items |
|---|---|---|---|---|---|
| *V0* | 0.726 | 0.914 | 8 | 2 | 6 |
| *V1* | 0.900 | 0.900 | 8 | | 8 |
| *V2* | 0.592 | 0.899 | 7 | 4 | 3 |
| *V3* | 0.906 | 0.906 | 3 | | 3 |
| *V4* | 0.716 | 0.756 | 4 | 1 | 3 |
| *V5* | 0.919 | 0.919 | 3 | | 3 |
| *V6* | 0.504 | 0.880 | 6 | 3 | 3 |
| *V7* | 0.796 | 0.796 | 3 | | 3 |
| *V8* | 0.824 | 0.824 | 3 | | 3 |
| *V9* | 0.660 | 0.660 | 3 | | 3 |
| *V10* | 0.681 | 0.737 | 5 | 2 | 3 |
| *V11* | 0.825 | 0.825 | 3 | | 3 |
| *V12* | 0.853 | 0.853 | 3 | | 3 |
| *V13* | 0.889 | 0.889 | 4 | | 4 |
| *V14* | 0.751 | 0.801 | 4 | 1 | 3 |
| ***TOTAL*** | | | **67** | **13** | **54** |

Source: Prepared by the author.

## RESULTS

### Final Survey

The final survey included 62 items, of which 8 were control items and 54 research items, the latter divided into 14 critical attributes or constructs according to the model proposed for the research. A total of 190 valid surveys were obtained out of 210 completed. A link to the survey with a filling guide was sent to the responsible people within the company via digital communication (email, WhatsApp, other). Data was processed using the statistical software SPSS version 25.0 for Windows and Excel 2019 (Table 4).

As the questionnaire comprises 54 items and 14 constructs (critical attributes), it was necessary to subject each construct to an exploratory factor analysis to determine its appropriate configuration, as shown in Table 5.

As shown in Table 5, after carrying out the factor analysis of the constructs, it is determined that they are relevant. Furthermore, based on the original model, it is possible to create more homogeneous groups of constructs according to their correlation and interdependence.

The model of the new distribution of factors is shown in Figure 3.

On account of the type of model proposed, it is necessary to work on the basis of the 14 attributes. Table 4 shows the internal consistency of each attribute, all of which have a Cronbach's alpha coefficient greater than 0.81, indicating that the internal consistencies are adequate.

Cronbach's alpha coefficient of the 54 items is 0.961, which shows that they have a very good overall consistency (Table 6).

As shown in the table above, the general hypothesis is accepted, because the resulting significance level of the test is less than 0.05. Also, the general hypothesis has a significant positive correlation at 0.770.

### Final Model

The final model is shown in Figure 4. It does not include the "environment" factor, since its critical attributes were rejected because they obtained significance levels greater than 0.05 in the result of the hypotheses.

## DISCUSSION

The critical attribute management ICT experience (V14) is accepted because the significance level is less than 0.05, with a weak negative correlation of 0.271.

**Table 4.** *Reliability of the Final Instrument.*

| CSA | Control Questions | Cronbach's Alpha | Items |
|---|---|---|---|
| V0 | ICT adoption | 0.891 | 6 |
| V1 | Perceived benefits | 0.943 | 8 |
| V2 | Perceived complexity | 0.882 | 3 |
| V3 | Perceived security | 0.908 | 3 |
| V4 | Perceived cost | 0.914 | 3 |
| V5 | Technological readiness | 0.839 | 3 |
| V6 | Previous technological experience | 0.860 | 3 |
| V7 | Resistance to change | 0.995 | 3 |
| V8 | Organizational culture | 0.866 | 3 |
| V9 | Pressure from suppliers | 0.841 | 3 |
| V10 | Pressure from competitors | 0.814 | 3 |
| V11 | Government support | 0.857 | 3 |
| V12 | Senior management commitment | 0.988 | 3 |
| V13 | Managers' attitudes towards ICT adoption | 0.854 | 4 |
| V14 | Management ICT experience | 0.832 | 3 |
| **$V_{1-14}$** | | **0.961** | **54** |

Source: Prepared by the author.

**Table 5.** *Rotated Component Matrix.*

| CSA | Variable Description | Items | Item Correlation | | | |
|---|---|---|---|---|---|---|
| | | | 1(T) | 2(I) | 3(E) | 4(O) |
| V9 | Pressure from suppliers | 3 | **0.973** | | | |
| V8 | Organizational culture | 3 | **0.972** | | | |
| V3 | Perceived safety | 3 | **0.967** | | | |
| V4 | Perceived cost | 3 | **0.965** | | | |
| V2 | Perceived complexity | 3 | **0.956** | | | |
| V1 | Perceived benefits | 8 | **0.667** | | | |
| V13 | Managers' attitudes towards ICT adoption | 4 | | 0.845 | | |
| V12 | Top management commitment | 3 | | 0.752 | | |
| V11 | Government support | 3 | | 0.694 | | |
| V5 | Technological readiness of staff | 3 | | 0.587 | | |
| V10 | Pressure from competitors | 3 | | | 0.860 | |
| V6 | Previous technological experience | 3 | | | 0.798 | |
| V7 | Resistance to change | 3 | | | | **0.853** |
| V14 | Management ICT experience | 3 | | | | 0.740 |

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaizer Normalization.

Source: Prepared by the author.

For the critical attributes perceived benefits (V1), users' technological readiness (V5) and managers' attitudes towards ICT adoption (V13), a significant positive correlation is observed, as the resulting correlation ranges from 0.758 to 0.780. Therefore, it can be said that there is a significant positive correlation between these attributes and the adoption of ICTs in industrial MSEs in Metropolitan Lima.

For the critical attributes perceived security (V3), perceived cost (V4), organizational culture (V8), pressure from suppliers (V9), government support (V11) and commitment of top management (V12), a medium positive correlation is observed, since the resulting correlation ranges between 0.553 and 0.611. Thus, it can be said that there is a medium positive correlation between these hypotheses and

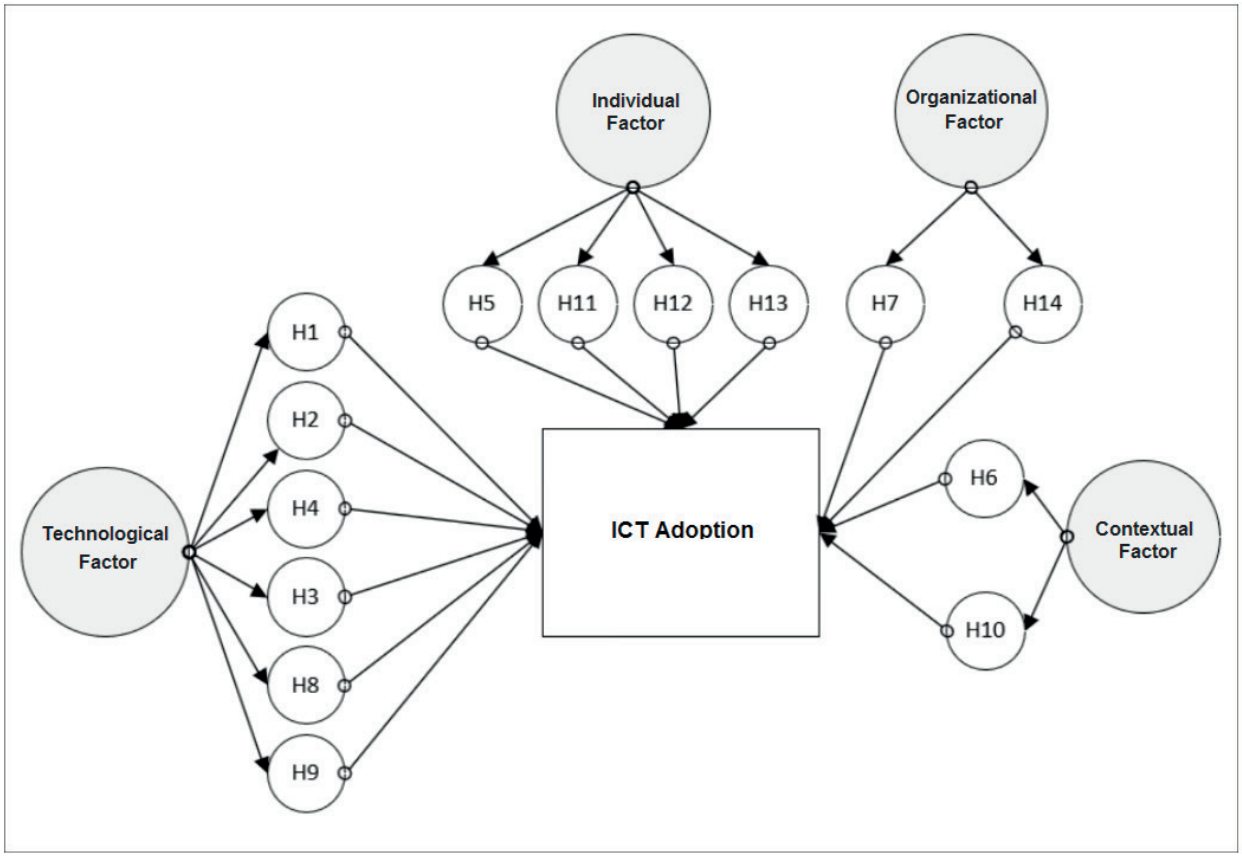


***Figure 3.*** Model - Factor Analysis.
Source: Prepared by the author.

**Table 6.** *Summary of Hypothesis Testing.*

| | CSA | Sig. | | Correlation |
|---|---|---|---|---|
| | General hypothesis | 0.000 | 0.770 | Significant positive correlation |
| V1 | Perceived benefits | 0.000 | 0.780 | Significant positive correlation |
| V2 | Perceived complexity | 0.000 | 0.670 | Medium positive correlation |
| V3 | Perceived security | 0.000 | 0.611 | Medium positive correlation |
| V4 | Perceived cost | 0.000 | 0.606 | Medium positive correlation |
| V5 | Technological readiness of users | 0.000 | 0.758 | Significant positive correlation |
| V6 | Previous technological experience | 0.622 | 0.036 | No correlation between variables |
| V7 | Resistance to change | 0.544 | -0.044 | No correlation between variables |
| V8 | Organizational culture | 0.000 | 0.586 | Medium positive correlation |
| V9 | Pressure from suppliers | 0.000 | 0.597 | Medium positive correlation |
| V10 | Pressure from competitors | 0.561 | 0.042 | No correlation between variables |
| V11 | Government support | 0.000 | 0.564 | Medium positive correlation |
| V12 | Senior management commitment | 0.000 | 0.553 | Medium positive correlation |
| V13 | Managers' attitudes towards IT adoption | 0.000 | 0.772 | Significant positive correlation |
| V14 | Management ICT experience | 0.000 | 0.271 | Medium negative correlation |

Source: Prepared by the author.

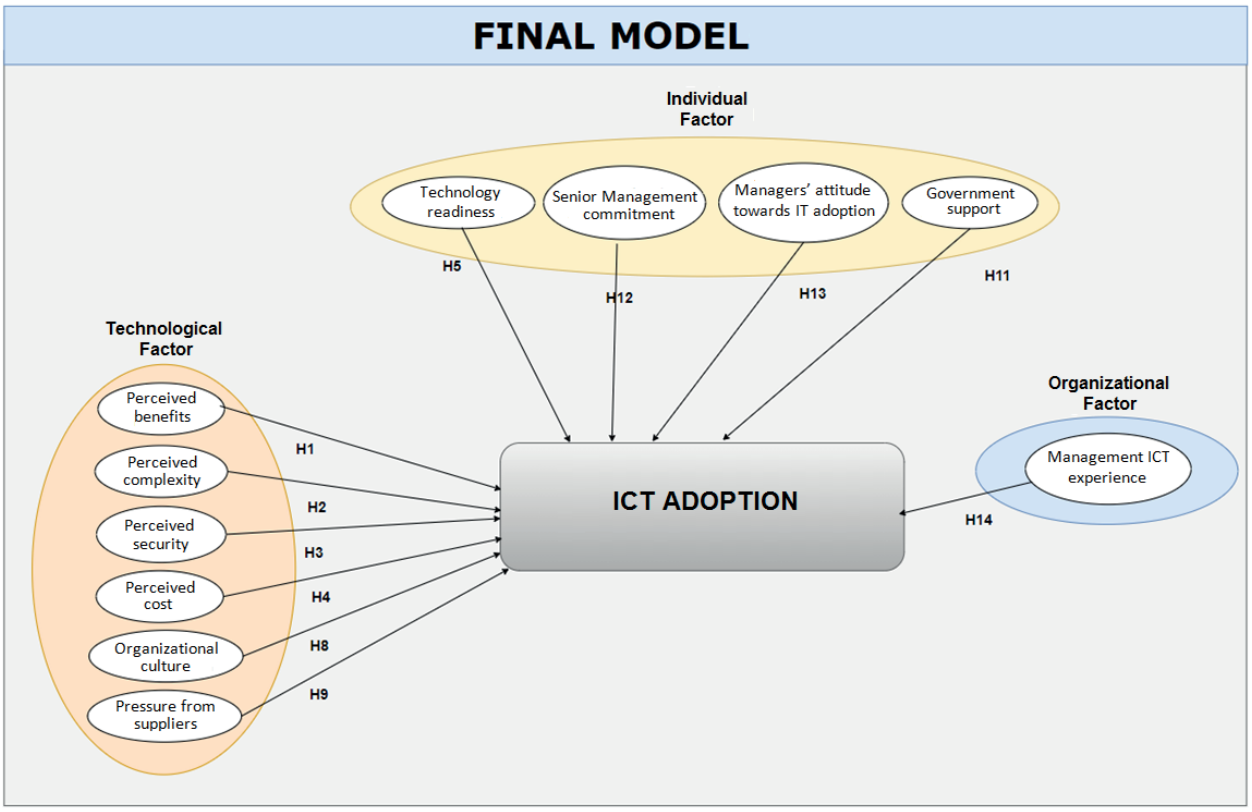


***Figure 4***. Model resulting from the accepted hypotheses.
Source: Prepared by the author.

the adoption of ICTs in the industrial MSEs in Metropolitan Lima.

On the other hand, critical attributes previous technological experience (V6), resistance to change (V7) and pressure from competitors (V10), are rejected because the significance level is greater than 0.05.

The proposed conceptual framework allows researchers to empirically test and understand the critical factors for ICT adoption in MSEs in Metropolitan Lima. These factors are critical for the successful adoption of ICTs in MSEs.

Current ICT adoption patterns can be analyzed within this proposed framework and specific suggestions can be provided to improve the model.

This study also enhances the knowledge of the critical factors for ICT adoption in MSEs and helps managers to better assess the condition of the enterprise and the possible critical factors that would lead to the successful adoption of ICTs in their enterprises.

The findings of this research are also expected to contribute to the academic field, small and medium-sized enterprises, consulting firms and software providers, and government agencies.

## CONCLUSIONS

Evidence in this research shows that there is a correlation between the factors proposed in the model and the adoption of ICTs in industrial MSEs in Metropolitan Lima, as shown in Table 6.

Critical factors "previous technological experience", "resistance to change" and "pressure from competitors" have no correlation with the adoption of ICTs in industrial companies in Metropolitan Lima.

Evidence from the research shows that the "environmental" factor disappears in the final model for the adoption of information and communication technologies in industrial companies in Metropolitan Lima, given that the proposed factors are not significant.

Fourteen critical factors were analyzed in this research; however, there may be others that are also

important and were not considered for the development of this model.

## RECOMMENDATION

The final model should be applied to the remaining Zones of APEIM 2020, by industry and nature of the products developed, in order to evaluate the model and analyze the results.

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