A Model for Implementing Enterprise Resource Planning Systems in Small and Medium-sized Enterprises

Daniela Tapia[1][a], Paola Vintimilla[2][b], Ximena Alvarez[2][c], Juan Llivisaca[2][d], Mario Peña[3][e], Rodrigo Guamán[2][f], Lorena Siguenza-Guzman[4][g] and Diana Jadan-Aviles[2][h]

[1]*Universidad de Cuenca, Ecuador*

[2]*Department of Applied Chemistry and Systems of Production, Faculty of Chemical Sciences, Universidad de Cuenca, Cuenca, Ecuador*

[3]*Research Department (DIUC,) Universidad de Cuenca, Cuenca, Ecuador*

[4]*Department of Computer Sciences. Faculty of Engineering. Universidad de Cuenca, Cuenca, Ecuador*

{estefania.tapia, paola.vintimilla, ximena.alvarez, juan.llivisaca, mario.penao, rodrigo.guaman, lorena.siguenza,

Keywords: SMEs, Enterprise Resource Planning, Interpretive Structural Model.

Abstract: Small and medium-sized enterprises (SMEs) are considered dynamic agents within the business environment. Currently, SMEs have great potential for strong growth and great profit. However, their growth is restricted by the lack of systems that would allow integrating their data and activities. One possible solution is the implementation of Enterprise Resource Planning (ERP) systems to increase the company's level of efficiency, effectiveness, and productivity. However, implementation processes require investing resources and bring certain problems, e.g., the difficulty to fully adapt to the organization's accounting and management procedures, and lack of experience of end-users in handling ERP systems. The aim of this study is focused on constructing a model for successfully implementing ERP systems into SMEs. This model used a group of critical success factors (CSF) to analyze empirical evidence in organizations. To its development, the interpretive structural modeling methodology was used, and it was validated in a focus group of experts in implementing and using ERP systems. The results show that the model is adequate for a successful implementation in SMEs engaged in sales, production, or service activities.

1 INTRODUCTION

Currently, enterprises face new challenges in changing markets. For them, it is essential to improve internal processes to obtain greater profits and benefits. A factor frequently used to improve productivity and business competitiveness is technological innovation. Companies are more likely to succeed when they make use of technological advances (Guerrero, Marín, and Bonilla, 2018).

One technological tool for managing the activities and resources of a production system is Enterprise Resource Planning (ERP). An ERP system is designed to integrate all the information coming from the material flow, workers, and financial resources of an organization through a common database. These systems allow efficient and automated management of manufacturing and production, finance and accounting, sales and marketing, and human resources processes (Laudon and Laudon, 2012; Sánchez, García, and Ortiz, 2017). Several authors

[a] https://orcid.org/0000-0002-2331-0939
[b] https://orcid.org/0000-0002-8194-6054
[c] https://orcid.org/0000-0001-6724-7997
[d] https://orcid.org/0000-0003-2154-3277
[e] https://orcid.org/0000-0002-3986-7707
[f] https://orcid.org/0000-0002-9577-0264
[g] https://orcid.org/0000-0003-1367-5288
[h] https://orcid.org/0000-0002-7264-5188

Tapia, D., Vintimilla, P., Alvarez, X., Llivisaca, J., Peña, M., Guamán, R., Siguenza-Guzman, L. and Jadan-Aviles, D.
A Model for Implementing Enterprise Resource Planning Systems in Small and Medium-sized Enterprises.
DOI: 10.5220/0010483200950104
In *Proceedings of the 23rd International Conference on Enterprise Information Systems (ICEIS 2021) - Volume 1*, pages 95-104
ISBN: 978-989-758-509-8

like Villacreses and Cedeño (2017), Deshmukh, Thampi, and Kalamkar (2015), and Grandón, Ramírez, and Rojas (2018) show that implementing an ERP system benefits companies and achieves expected results. However, the process of implementing an ERP system is not always successful. Rivera, Reyes, and Arévalo (2018) state that a third of the implementation projects are unsuccessful; and about 65% of the application cases fail for several reasons.

It is complex to describe advantages and disadvantages of ERP systems and their implementation. Many authors present important facts that should be taken into account. For example EL Mrini et al. (2014) state that implementing an ERP provides a structural change on all the company's bricks: operational, organizational and cultural. These authors also mention that the ERP implementation projects can paralyze the company if they are not properly implemented. Abugabah (2017) specifies that ERP systems are viewed as powerful solutions that help improve productivity, performance and overall quality; however, the effective use and the beneficial outcomes from the systems are not guaranteed nor recognized by many organizations.

In small and medium-sized enterprises (SMEs), the case of ERP systems implementation projects is studied in different papers. For instance, Rivera and Pérez (2013) indicate that some critical factors can augur success or failure in the ERP implementation, such as the type of system selected based on the marketing, production, or service activities. These challenges appear at internal and external organization levels. At the internal level, these systems help maintain control; at the external level, they can-not be manipulated or changed by the company (Palomo, 2005). Kauffman (2001) points out that the limitations for ERP implementation in SMEs at an internal level are: 1) a lack of efficient systems of planning, organization, administration, and control, and 2) insufficient technologies for managing and developing production. Similarly, Artola and Artieda (2014) conclude that the SMEs' weaknesses to automate for their business through an ERP include: 1) difficulty in accessing credits due to their high cost, and 2) insufficient financial resources to support the use of technology.

Besides, ERP requires a high degree of integration. However, most organizations do not have defined processes or an appropriate organizational structure to fully integrate the ERP into their systems. The idea of solving business integration problems through ERP systems is attractive; however, the benefits price is high. Implementing ERP systems requires high capital investments and considerable time. The latter influences the organizational culture of the company. Extensive training, temporary productivity drops, and slower delivery of orders to customers during the ERP transition alter the quality of the enterprise service (EJ Umble and Umble, 2002).

In the Ecuadorian context, SMEs are characterized by their familiar and traditional structure, often built on the empiricism basis and with strong change resistance. Nevertheless, this sector has been really important for boosting local economies and generating employment.

The objective of the current paper is to establish a successful ERP implementation model for Ecuadorian SMEs. To this end, several studies have been taken as a reference to identify the critical factors and keys for the implementation success of an ERP system. In particular, the study by Bernal (2019) focuses on the Austral business environment in Ecuador. This study has contributed with a valuable list of 31 critical success factors (CSF) for the successful ERP implementation in SMEs. These factors have been considered from a business perspective in order to structure and integrate them into the implementation model.

2 METHODS

The purpose of this study is to find a successful model for ERP implementation in SMEs. The 31 CSF proposed by Bernal, (2019) were used in the interpretative structural model.

2.1 Interpretative Structural Model

The interpretive structural model (ISM) complies with the necessary parameters for its construction, adapts to the context of the study, and considers a series of CSF. ISM identifies the relationships among the components facing the same complex situation. These relationships are given among factors directly or indirectly.

Thus, the final model is based on the construction of three sequential matrices: 1) the structural self-interaction matrix (SSIM), which is responsible for establishing the contextual relationship among factors; 2) then, SSIM becomes a reachability matrix (binary) where its transitivity is verified; and finally, 3) a multilevel model is obtained which expresses through a graph the direct and indirect relationships among analyzed factors.

2.2 Study Sample

A non-probabilistic convenience sampling technique was used with a focus group of experts in ERP systems implementations and uses. This process helped to determine the model's validity.

2.3 Methodology

The proposed methodology required a previous literature review regarding fundamental concepts for its application. The methodology developed during this investigation is summarized in Figure 1.

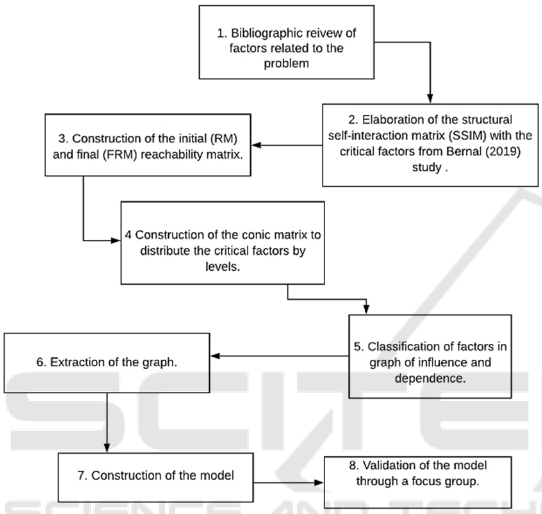

Figure 1: Research methodology (Raj, Shankar, and Suhaib, 2008).

Step 1: A literature review of topic related factors.

This bibliographic review was considered from two approaches: Critical factors established from business experience (16 factors) and Critical factors established from the personal perception of experts (22 factors). However, this paper only presents the business experience approach, because ERP systems have been used mainly in this sector. In addition, due to the complexity in the communication that it has in companies it is very important.

In this step a principal component analysis (PCA) was performed. According to López and Fachelli (2015), the criteria to determine the PCA approach are the following:

1) Consider all factors with an eigenvalue greater than 1 in terms of the total variance. 2) Consider the number of axes that accumulates around 70% of the total variance, however, lower values have been considered due to their importance. 3) Represent the factors and the associated eigenvalues graphically, by observing the behaviour of the resulting curve through the sedimentation graph.

In this way, necessary components and integrating factors were determined. The factors of PCA are detailed in Table 1.

Table 1: Critical Success Factors (Bernal, 2019).

Code	**CSF for ERP successful implementation**	**Component**	
		1	**2**
CSF: Strategic			
x1	Support from Senior Management	**0,912**	0,255
x2	Project Management	**0,867**	0,122
x3	Use of a Steering Committee	**0,593**	0,398
x4	Business Process Reengineering BPR	0,114	**0,922**
x5	Goals and Objectives	0,410	**0,831**
CSF: Support			
x6	Participation of the change management	**0,854**	0,148
x7	Interdepartmental Cooperation	**0,805**	0,153
x8	Communication	-0,002	**0,854**
x9	Relationship with suppliers and support	0,505	**0,678**
x10	External Consultants	0,523	**0,623**
CSF: Operational			
x11	ERP System Configuration	**0,881**	0,204
x12	IT Structure and Legacy Systems	**0,821**	0,095
x13	Skills, Knowledge and Experience	**0,776**	0,159
x14	ERP System Acceptance / Resistance	**0,666**	0,385
x15	ERP System Organizational Adjustment	0,088	**0,903**
x16	Participation of End Users and Stakeholders	0,317	**0,830**

Step 2: SSIM elaboration with the CSF of Bernal (2019).

The SSIM matrix was created using the relationships proposed by Routroy and Kumar (2014), presented in Table 2.

As an example, for factor x7, the lower diagonal indicates that position *i* influenced the factor x2 that is in the position *j*. Then, in the box (7,2), the symbol "V" was located (Table 3).

Table 3: Structural self-interaction matrix.

N°	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16
x1	-															
x2	A	-														
x3	X	A	-													
x4	A	A	A	-												
x5	A	X	A	V	-											
x6	A	X	A	V	A	-										
x7	A	V	X	V	X	V	-									
x8	X	X	A	X	A	V	V	-								
x9	X	A	X	V	A	O	O	X	-							
x10	X	O	X	V	A	O	O	O	X	-						
x11	A	A	A	A	A	A	O	O	A	A	-					
x12	A	A	A	A	A	V	O	O	X	O	X	-				
x13	A	V	V	V	V	V	V	A	V	V	V	V	-			
x14	A	A	A	O	A	X	V	A	X	A	A	X	A	-		
x15	A	A	A	A	A	A	O	A	O	A	A	A	V	O	-	
x16	A	A	A	X	A	A	X	A	A	A	A	A	A	V	V	-

Table 2: Symbology for the SSIM matrix (Routroy & Kumar, 2014).

Symbology	Description
V	Factor *i* influences or is driven to factor *j*
A	Factor *j* influences or is driven to factor *i*
X	Factor *i* and factor j are related in both directions
O	There is no relationship between factor *i* and factor *j*

Step 3: Initial (RM) and final (FRM) reachability matrices elaboration.

First, an isomorphic transformation was made. This means that the symbol matrix (VAXO) was transformed into a binary matrix called the initial reachability matrix (RM). For this, the rules proposed by Raj, Shankar, and Suhaib (2008), shown in Table 4, were used.

Table 4: Symbology for the RM matrix (Raj, Shankar, and Suhaib, 2008).

	V	A	X	O
Input (i, j)	1	0	1	0
Input (j, i)	0	1	1	0

Second, the concept of transitivity was introduced, used to elaborate the final reachability matrix (FRM). The transitivity rule, given by Rajesh et al. (2008), consists of relating the factors of the RM matrix whose value inside its box is zero. In other words, the transitivity in this study has been established by constructing the matrix graph (RM).

A brief example of this graph construction can be seen in Figure 2. Note how a direct relationship originates from node x2 towards x16 and the same occurs from node x16 to node x7. Thus, it is concluded that there is transitivity (dashed line) between box x2 (*i*) and x7 (*j*) which was replaced by “1a” in the FRM matrix.

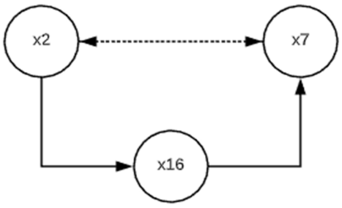

Figure 2: Example of transitivity.

The comparisons between the nodes were made in pairs or by inferences to fill each box where there is a crossover of matrix variables. Thus, pairwise comparisons were reduced by 50% to 80%. It is also an advantage that many relationships in the system were transitive (Watson, 1978).

Step 4: Conic matrix elaboration to distribute the CSF by levels.
The conic matrix was prepared based on the matrix (FRM), and from it, the levels for the location of each factor within the models were defined.

Step 5: Classification of CSF in the power of influence and dependence diagram.
For this, factors have been classified into autonomous, dependent, independent, and linked clusters. Each cluster measures dependency and influence on a scale.

Step 6: Extracting the graph.
Considered the results of Step 4 and presents the relationships existing among the CSF.

Table 5: Initial reachability matrix.

N°	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16
x1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
x2	0	-	1	1	1	1	0	1	1	0	1	1	0	1	1	1
x3	1	0	-	1	1	1	1	1	1	1	1	1	0	1	1	1
x4	0	0	0	-	0	0	0	1	0	0	1	1	0	0	1	1
x5	0	1	0	1	-	1	1	1	1	1	1	1	0	1	1	1
x6	0	1	0	1	0	-	0	0	0	0	1	0	0	1	1	1
x7	0	1	1	1	1	1	-	0	0	0	0	0	0	0	0	1
x8	1	1	0	1	0	1	1	-	1	0	0	0	1	1	1	1
x9	1	0	1	1	0	0	0	1	-	1	1	1	0	1	0	1
x10	1	0	1	1	0	0	0	0	1	-	1	0	0	1	1	1
x11	0	0	0	0	0	0	0	0	0	0	-	1	0	1	1	1
x12	0	0	0	0	0	1	0	0	1	0	1	-	0	1	1	1
x13	0	1	1	1	1	1	1	0	1	1	1	1	-	1	0	1
x14	0	0	0	0	0	1	1	0	1	0	0	1	0	-	0	0
x15	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	0
x16	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	-

Table 6: Final reachability matrix.

N°	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16	Power of Influence
x1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
x2	1a	-	1	1	1	1	1a	1	1	1	1	1	1a	1	1	1	15
x3	1	1a	-	1	1	1	1	1	1	1	1	1	1a	1	1	1	15
x4	1a	1a	0	-	0	1a	1a	1	1a	0	1	1	1a	1a	1	1	12
x5	1a	1	1a	1	-	1	1	1	1	1	1	1	1a	1	1	1	15
x6	0	1	1a	1	1a	-	1a	1a	0	0	1	1a	1a	1	1	1	12
x7	1a	1	1	1	1	1	-	1a	1a	1a	1a	1a	0	1a	1a	1	14
x8	1	1	1a	1	1a	1	1	-	1	1a	1a	1a	1	1	1	1	14
x9	1	1a	1	1	1a	1a	1a	1	-	1	1	1	1a	1	1a	1	15
x10	1	1a	1	1	1a	1a	1a	1a	1	-	1	1a	1a	1	1	1	15
x11	0	0	0	1a	0	1a	1a	0	1a	0	-	1	1a	1	1	1	9
x12	1a	1a	1a	1a	0	1	1a	1a	1	1a	1	-	1a	1	1	1	14
x13	1a	1	1	1	1	1	1	1a	1	1	1	1	-	1	1a	1	13
x14	1a	1a	1a	1a	1a	1	1	1a	1	1a	1a	1	0	-	1a	1a	14
x15	0	1a	1a	1a	1a	0	1a	0	1a	1a	1a	1a	1	1a	-	1a	12
x16	0	1a	1a	1	1a	1a	1	1a	1a	0	1a	1a	1a	1	1	-	13
Dependency power	11	14	13	15	12	14	15	13	14	11	15	15	13	15	15	14	

Step 7: Model proposal for the implementation of ERP systems.
Based on Step 6, a model was built that allowed visualizing the relationships of the factors.

Step 8: Validation of the proposed model through a focus group.
Step 7 was validated using a focus group, with experts who have several years of experience in the ERPs implementation. This validation followed the recommendations of Mendoza, González, and Pino (2013) for panel structure and data treatment.

3 RESULTS

When implementing an ERP system, the importance of certain factors is crucial to guarantee success in the company. In this sense, the presence of CSF in the implementation model obtained is exposed. And, the impact they will have at the time of implementation can be seen, corroborating the hypothesis for this research.

According to experts' opinion, the contextual relationships established in the lower diagonal of the SSIM matrix mostly indicate an influence between the critical factors from position *i* to position *j*, as can be seen in Table 3. These results were crucial for the development of the following matrices since the model's success depends on these relationships.

Then, the VAXO symbol matrix became a completely binary matrix, both for the upper and lower diagonal. Table 5 shows the initial RM in which the cells are mostly occupied by the number one, this means that the presence of transitivity in this matrix will be very significant.

In the FRM, a matrix with a great presence of transitivity was obtained. By adding these transitive cells, i.e., cells having the reference "1a", together with the cells occupied by the numbers one both in the rows and in the columns, the power of influence and dependence for each factor were obtained. These values were proportional to each other, being very important data for the analysis when validating the model. The detail of this matrix is found in Table 6.The conic matrix indicates the distribution of each factor in its respective level, obtaining a total of 16 iterations, 7 iterations corresponding to level 1, 6 iterations for level 2, and 3 iterations for level 3. Each iteration means an assigned factor at a level. These iterations allowed diagraming the final model with the relationships established between each critical factor according to the level at which they are located.

By clustering CSF (Figure 3), it is observed that the first three quadrants do not have the presence of any factor. However, for quadrant IV, the 16 factors are present with a strong influence of each factor on the other according to the literature established by Routroy and Kumar (2014). And so, these factors required feedback for the structuring of the model, where their relationships were based mainly on influence and dependence.

Finally, the model obtained is made up of three levels, where the third “strategic” level was placed at the bottom as the base of the model. The name assigned to this level is because the factors located are responsible for making the decisions of the entire project and will have a significant impact on the performance of the following levels. The factors at this level begin to be directly and indirectly related to the factors located in the second level, also called the internal level, since the factors located have functions that only involve the organization and its personnel. These factors are related in the same manner to factors located at level 1, the operational level containing the factors responsible for finalizing the implementation and supervising the operation of the ERP system in SMEs. The final model can be observed in Figure 4.

4 DISCUSSION

Once the model was formulated and validated, a more precise relationship was established between the critical factors within the context of SMEs. The results obtained in the model are discussed from the application of the ISM methodology and its respective validation. According to the model generated, the results obtained have been given in three levels, starting from the bottom or base, towards the top of the model. The validated model is shown in Figure 5.

4.1 Strategic Level (Level 3)

In level 3, three key factors can be observed: 1) Support from Senior Management (x1), 2) Relationship with Suppliers and Support (x9), and 3) External Consultants (x10). At this level, the implementation of an ERP begins, due to strategic decisions about the implementation and the assurance of success. This is corroborated with the results obtained in the power of influence and dependence diagram concerning the factors x1 and x10 of support for senior management, that is, based on the dependence that exists between them.

Despite the fact that, a transitive relationship (dashed line) between External Consultants (x10) and Change Management (x6) can be observed, in the validation processes, this transitivity has been eliminated. The experts have stated that change management involves decisions purely internal to the company without having any kind of contact with external consultants. Likewise, based on the relation between Communication (x8) and the Relationship with Suppliers and Support (x9), it is established that communication is a strategy that should only occur within the organization.

4.2 Internal Level (Level 2)

At this level, six internal factors of the organization are included: Change Management (x6), Project Management (x2), Use of a Steering Committee (x3), Skills, Knowledge, and Experience (x13), Clear Goals and Objectives (x5) and Communication (x8). Within the influence and dependency diagram, it is observed that the participation of the Change management (x6) is a factor highly dependent on the factors of the same level, being essential within the decision making processes in the organization.

Likewise, the clear Goals and Objectives (x5) presents low dependency; thus, when validating this relationship, the experts have decided to maintain the transitivity towards level 1. In other words, to reach these factors, it is necessary to make decisions at the strategic level (level 3). Regarding Skills, Knowledge, and Experiences (x13), despite being an influential factor and at the same time dependent on the use of a Steering committee (x3), the experts suggested eliminating this relationship. The reasoning behind this is that it presents a greater weight with external consultants and vendors that are

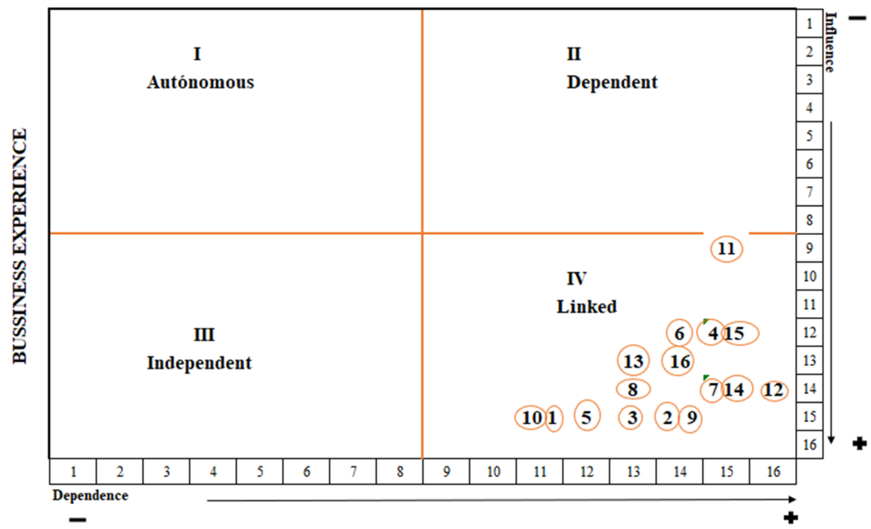

Figure 3: Diagram of power of influence and dependence of critical success factors.

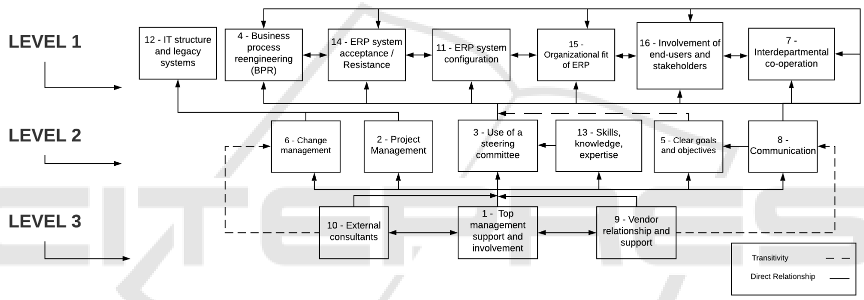

Figure 4: Structural model of critical success factors for implementation in SMEs.

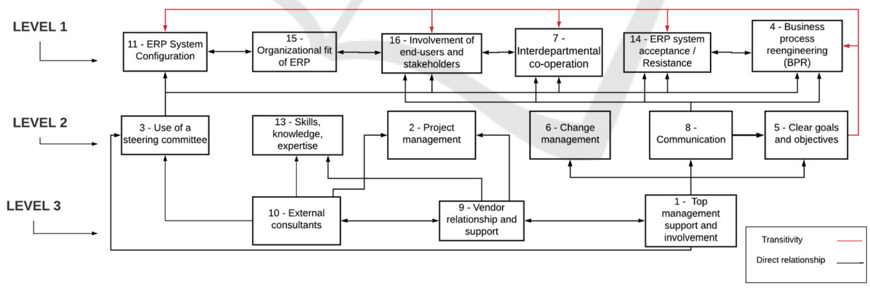

Figure 5: Validated structural model of critical success factors for implementation in SMEs.

factors that help ensure a successful implementation.

At this internal level, communication and information and knowledge exchange strategies have been established. These will help project management and change within the organization, by integrating all areas affected during implementation.

4.3 Operational Level (Level 1)

This level has seven factors: IT Structure and Legacy Systems (x12), Business Process Reengineering BPR (x4), ERP System Acceptance / Resistance (x14), ERP System Configuration (x11), ERP System Organizational Adjustment (x15), Participation of End Users and Stakeholders (x16), Interdepartmental Cooperation (x7). It has been named at this level as operational because it contains factors responsible for the implementation of the ERP system. The ERP System Configuration (x11) within the influence and dependency diagram has been estimated as a highly dependent operating factor because its configuration must be processed in parallel with the activities of the factors of its same level. Nevertheless, this factor is key for implementation at the operational level. In fact, standard ERP systems are unable to fully adapt to a company's processes (Gool and Seymour, 2018). This dependence can be observed in the diagram of power of influence and dependence of CSF in Figure 3.

The IT Structure and Legacy Systems (x12), even though it has been observed to be a highly dependent factor, it was discarded by the experts based on their knowledge and expertise. They argued that the presence of this factor does not have a major influence on the final stage of implementation of this ERP system in SMEs, since this kind of organization does not necessarily have a structured database.

It has been initially observed that the ERP System Configuration (x11) together with the ERP System Acceptance (x14) are highly dependent factors within the implementation and maintaining a bidirectional relationship. However, during the validation, this relationship was null because their dependence does not add a weighted value when performing the implementation.

A key part of the model validation carried out by the experts is the fact that SMEs have adequate implementation strategies. According to this, interdepartmental cooperation, process reengineering, and acceptance of the ERP system are essential since, at the end of the implementation process, the system operation must be corroborated.

The current results were contrasted with other similar cases, such as the study carried out by Pinto, Ramírez, and Grandón (2017), who investigated the antecedents of success in implementations of ERP systems. This work reduced all factors to three dimensions such as the organization, the project, and the people. These dimensions include the critical factors most valued by companies, which are favorably complemented by the current factors involved in this study, as well as, their approaches to the project, the development of the organization in the face of the implementation of an ERP, and its staff.

This indicates that by taking into account these three aspects, the estimation of the implementation time will be shorter and able to better adapt to the business processes to which any organization is dedicated.

5 CONCLUSIONS

The most relevant resources of the experts' validation show that SMEs need the participation and commitment of the top management, a good relationship with the service providers and the external consultants.

The participation and commitment of top management are essential for the implementation of this type of system, especially when it depends on the resource allocation and the possible process changes. The model obtained in the present investigation places the greatest emphasis on the importance of top management in the search and selection phases of the system to be implemented.

In addition, the model presented allows greater attention to the top management in the enterprise preparation while implementing the ERP system because it increases the probability of achieving success.

Another fundamental pillar to achieve success in the implementation of ERP systems is effective communication between the different actors. It is achieved when the value-adding processes are known by all the stakeholders of the implementation, and the origin and reliability of the information are known for sure.

It is relevant to establish a partner relationship with the suppliers of the system. Such suppliers must respect business decisions and ethically indicate to their customers all possible advantages and disadvantages of their product. Besides, to allow easy implementation and accessibility for SMEs, suppliers can provide ERP in the cloud, offered as: IaaS (infrastructure as a service) SaaS (software as a service) and PaaS (platform as a service).

It is important to highlight the participation of the end-user in all implementation phases (Abugabah, 2017) the organization must seek strategies to reduce the change resistance to the sustainability of the implemented system over time.

There are some limitations to this investigation due to the number of samples used to generalize the results. Likewise, most of the data was taken from manufacturing companies due to its high percentage in the Austral zone of Ecuador.

As future work, at a research-level, the ISM methodology can be integrated with Fuzzy relationships to quantitatively show the existing connections between levels of the model. In addition, this work could guide SMEs to build a set of indicators while they implement an ERP system.

ACKNOWLEDGEMENTS

This study is part of the research project “Analysis and definition of strategies and scenarios for the successful implementation of Enterprises Resources Planning systems in the south of Ecuador" supported by the Research Department of the University of Cuenca (DIUC).

REFERENCES

Abugabah, A. (2017). Enterprise Systems: The Quality of System Outputs and their Perceived Business Value.In Proceedings of the 19th International Conference on Enterprise Information Systems - Volume 3: ICEIS, ISBN 978-989-758-247-9, pages 338-342. DOI: 10.5220/0006351203380342

Artola, C, and Artieda, C. (2014). *Feasibility study for the implementation of an ERP as software as a service for the sales force of an SME*. (Master´s thesis). National polytechnic Ecuador, Ecuador. Recovered from: https://bibdigital.epn.edu.ec/bitstream/15000/7678/1/CD-5633.pdf

Bernal, R. (2019). *Identificación y Análisis de factores Críticos de Éxito para Implementación de Sistemas ERP en Pymes: Caso Provincia del Azuay.* (Undergraduate thesis). University of Cuenca, Cuenca

Deshmukh, P., Thampi, G., and Kalamkar, V. (2015). Investigation of Quality Benefits of ERP Implementation in Indian SMES. *Procedia Computer Science* (49), 220-28. DOI: 10.1016/j.procs.2015.04.247

Gamarra, L, and Cornejo, G. (2018). *Opensource ERP implementation model for SMEs in the automotive sector*. (Undergraduate thesis). Peruvian University of Applied Sciences, Lima. DOI: 10.19083/tesis/625006.

Grandón, E., Ramírez, P., and Rojas, K. (2018 Use of Business Process Change (BPC) theory to examine the adoption of Enterprise Resource Planning (ERP) in Chile. *Interscience.* 43(10), 716-22.

Gool, S. and Seymour, L. (2018) Managing Enterprise Resource Planning System Customisation Post-Implementation. In Proceedings of the 20th International Conference on Enterprise Information Systems (ICEIS 2018), pages 111-119. DOI: 10.5220/0006676401110119

Guerrero, A., Marín, M. and Bonilla, D. (2018) *Erp como alternativa de eficiencia en la gestión financiera de las empresas*. Revista Lasallista de investigación, ISSN 1794-4449, Vol. 15, Nº. 2, 2018, págs. 182-193.

Kauffman, S. (2001). The Development of Micro, Small and Medium Enterprises: A Challenge for the Mexican Economy. *University Veracruzana.* 40-48. Recovered from: https://www.uv.mx/iiesca/files/2013/01/empresas2001-1.pdf

Laudon, K and Laudon, J., (2012). *Management information systems*. México D.F, (México): 12.a ed: Pearson. Recovered from: https://guillermoprblog.files.wordpress.com/2016/03/sistemas-informac-gcial-12ed-laudon-y-laudon.pdf

López, P., & Fachelli, S. (2015). Quantitative Social Research Methodology (1st edition). Recovered from: http://ddd.uab.cat/record/129382

Mendoza, M., González, C., and Pino, F. (2013). Focus group as a process in software engineering: An experience from practice. *Dyna Journal* 80(181), 51-60. ISNN: 2346-2183

Mrini, Y. E., Okar C., Belaissaoui, M. and Taqafi I. (2015). Difficulties related to implement enterprise resource planning in Morocco Large companies' case study, 2015 World Congress on Information Technology and Computer Applications (WCITCA), Hammamet, Tunisia, 2015, pp. 1-6, DOI: 10.1109/WCITCA.2015.7367025.

Palomo, M. (2005). Management processes and the problems of SMEs. *ResearchGate*. 8, 2. Recovered from: https://www.researchgate.net/publication/228623217_Los_procesos_de_gestion_y_la_problematica_de_las_PYMES

Raj, T., Shankar, R. and Suhaib, M. (2008). Un enfoque ISM para modelar los habilitadores de un sistema de fabricación flexible: el caso de India. *International Journal of Production Research* 46(24), 6883-6912. DOI: 10.1080/00207540701429926

Rivera, A., Reyes, R., and Arévalo, L. (2018). Implementation of Enterprise Resource Planning (ERP) Systems in Organizations Since Coevolution. *Solidarity Engineering.* 14(15),1-15. DOI: 10.16925/in.v14i24.2161

Rivera, I., and Pérez, M. (2013). ERP selection guide in small and medium Mexican companies. *Arbor.* 189(760), a025.DOI:10.3989/arbor.2013.760n2011

Routroy, S., and Kumar, S. P., (2014). Benchmarking model of supplier development for an Indian gear manufacturing company. *Benchmarking: An International Journal* 21(2), 253-275. DOI: https://doi.org/10.1108/BIJ-02-2012-0007

Sánchez, P., García, J and Ortiz, L. (2017). Methodology for the comparison of enterprise resource planning systems for port logistics services. *Chilean Journal of Engineering* 25(3), 547-60. DOI: http://dx.doi.org/10.4067/S0718-33052017000300547

Villacreses, J., and Cedeño, B. (2017). *Development and implementation of an ERP system using the Odoo platform with integration of social media and Ecuadorian legislation for automation, control of business processes in the "all criollo" company of the Manta canton*. (Undergraduate thesis). Secular University Eloy Alfaro of Manabí, Ecuador

Watson, R. H. (1978). Interpretive Structural Modeling: A Useful Tool for Technology Assessment. Technological Forecasting and Social Change Journal. 11(2), 165-185. DOI: 10.1016/0040-1625(78)900.