USER ACCEPTANCE OF OPEN ENTERPRISE SOLUTION: THE OSS-ERP CASE

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ABSTRACT

Organizations implement Enterprise Resource Planning (ERP) systems with the objective of reaching operational efficiency and the incorporation to new markets through the information flow control on time of the entire organization. However, ERP systems are complex tools, mainly for the small and medium size enterprises (SMEs). For these reason, new ERP configurations have arisen for SMEs such as Open Source Software-ERP (OSS-ERP). OSS-ERP is a research topic barely analyzed by the literature. Specifically, this paper's aim is to focus on the OSS-ERP users' acceptance and use. The authors have developed a research model based on the Technology Acceptance Model (TAM) for testing the users' behavior toward OSS-ERP.

RESUMEN

Las organizaciones implantan Sistemas Integrados de Gestión (ERP, acrónimo de Enterprise Resource Planning) con el objetivo de alcanzar eficiencias operativas y la incorporación a nuevos mercados mediante un mayor control del flujo de información de toda la empresa a tiempo real. Sin embargo, los sistemas ERP son herramientas complejas, principalmente la pequeña y mediana empresa (PYME). Por esta razón, están surgiendo nuevas configuraciones de sistemas ERP para PYME como los sistemas ERP de código abierto (OSS-ERP). OSS-ERP es un tópico de investigación escasamente analizado en la literatura. Concretamente, este artículo se centra en el y aceptación de los usuarios a los sistemas OSS-ERP. Los autores han desarrollado un modelo de investigación basado en Metamodelo de Aceptación de la Tecnología (TAM) para testar el comportamiento de los usuarios hacia los sistemas OSS-ERP.

1. INTRODUCTION

Enterprise Resource Planning (ERP) can be defined as that Information System (IS) which integrates relative organization tools, data and information flows by means of a data base (Davenport, 1998; Davenport, 2000; Jacobs and Whybark, 2000). The actual competitive environment has impelled that many organizations implement ERP systems. Furthermore, organizations implement ERP systems with the objective of reaching operational efficiency and the incorporation to new markets through the information flow control on time of the entire organization.

In spite of these ERP advantages for organizations, the main commercial ERP systems (i.e. SAP, Peoplesoft, Oracle, etc.) have relevant implementation obstacles: (1) high implementation complexity, (2) high average implementation time (3) high software, maintenance and consultation cost and (4) low adaptation flexibility (Bueno and Salmeron, 2008). Due to these characteristics, ERP systems are reasonable mainly for large organizations, although the small and medium size enterprises (SMEs) have the same necessities with respect to

the information management and control. For these reason, new ERP configurations have arisen for SMEs such as adapted ERP for SMEs, ERP through application service providers (ASP) or Open Source Software-ERP (OSS-ERP).

OSS was born as an answer to today's shaping of the software market and it has spread out through the main areas related to IS. OSS offers several organizational advantages, such as saving costs related to IS or the capacity to adapt to the changing enterprise requirements. These relevant advantages increase the attraction of technological solutions based on OSS as compared to proprietary technologies.

In spite of the increasing penetration of market of OSS-ERP, scientific studies do not exist on OSS-ERP. In particular, there aren't works that analyze the diffusion and acceptation of OSS-ERP. This research is focused in the OSS-ERP acceptance topic. Our purpose is to define a research model in order to observe the intention of use on OSS-ERP by users. With this objective, we have applied the Technological Acceptance Model (TAM) as the theoretical frameworks which have been formulated the research hypotheses.

The rest of the paper is organized as follows. In the section two, we expose the research context. In the section three and four, the hypotheses, our research model and design are explained. Finally, the findings and discussions are gathered.

2. BACKGROUND ON OSS-ERP

ERP is an old research field. Since the beginning of the decade of the 70s, the number of studies about ERP has been growing progressively around two research topics: (1) technical factors and (2) organizational impact. Although organizations perceive that ERP are complex tools, ERP are considered a strategic resource (Yen and Sheu, 2004) and they can provide organizations a high level of competitiveness by means of acquiring a strong market position (Tchokogue et al., 2005)

From a market view, ERP have covered the old necessity to improve the information control of an entire organization. Recently, ERP systems implementations have been growing strongly (Lea et al., 2005; Mabert et al., 2001; Wu et al., 2008; Ross and Vitale, 2000; Bendoly and Kaefer, 2004). Some authors, such as Seddon et al, (2003), affirm that the ERP market will reach one trillion of dollar in the year 2010. However, this growth would not be possible without the opening towards SMEs. This kind of companies considers to traditional ERP systems as expensive and complex tools with a high impact in organizational structures, process and culture (Holland and Light, 1999). For that reason, ERP complexity management can be considered a crucial activity (Fui-Hoon et al., 2001).

Based on this point of view, OSS-ERP reduce the disadvantages of ERP for the SMEs. OSS was born as an answer to today's shaping of the software market (Morgan, 2002). The strict translation of open source makes reference to the possibility to have access to source, whether the software is free (of charge) or not (Gallego et al., 2008). Actually, we have to indicate that the basis for the consolidation of OSS as an alternative to proprietary software is three-fold (Lerner and Tirole, 2002; Fuggetta, 2003).

Besides, OSS-ERP has three relevant advantages to organizations: (1) increased adaptability, (2) decreased reliance on a single supplier, (3) reduced costs (Serrano and Sarriegi, 2006). Generally, OSS-ERP include the necessary functions to manage integrally all the activities of a company. Due to their high flexibility, these tools can be adapted the client's specific needs. Furthermore, as OSS-ERP are based on open software technologies,

organizations are not put under the payment of licenses or exclusive contracts. With the collaboration of partners, OSS-ERP vendors receive benefits for the support services.

In the website Sourceforge.net, we can identify 2058 projects about OSS-ERP, although all has not had an impact in ERP market. This data is an indicative of the increasing relevance of this enterprise solution for organizations. In this moment, OSS-ERP vendor with greater diffusion are Compiere, Openbravo, Abanq (before FacturaLux), ERP5, Tiny ERP, Fisterra, OFBiz, SQL-Ledger and WebERP.

One of the key factors for fomenting the diffusion of OSS-ERP is the users' acceptance. OSS-ERP can produce relevant change in organizations during the implementation stage. In this sense, one of the main efforts of the change management is the promotion of actions that increases OSS-ERP users' acceptance. OSS-ERP success or failure will be largely determined by users' acceptance degree. One after another, it depends on the complexity of the transformations that OSS-ERP incorporate in organizations when they are implemented.

3. TAM METHODOLOGY AND HYPOTHESIS

The TAM model developed by (Davis, 1986) has been widely applied with the purpose of understanding the conduct and motivational factors that influence IS adoption and use. TAM is based on the Theory of Reasoned Action (TRA) proposed by Fishbein and Ajzen (1985). TAM tests the users behavior toward IS, based on the perceived usefulness (PU), perceived ease of use (PEU), attitude toward use (ATU) and behavioral intention to use (BIU). PU is the degree to which a person believes that using a particular system would enhance his or her job performance, and PEU as the degree to which a person believes that using a particular system would be free of effort (Davis, 1989).

Additionally, TAM postulates that BIU depends of IU of an IS (Davis, 1986). ATU are based on PU and PEU, although Davis (1986, 1989) doesn't detail what factors are exogenous variables. In relation to this aspect, (24) indicates three large groups of external variables: (1) regarding the user, (2) regarding the organization and (3) regarding to IS. On the other hand, TAM was designed to improving the measures for prediction and explanation of IS use (Davis et al., 1989.).

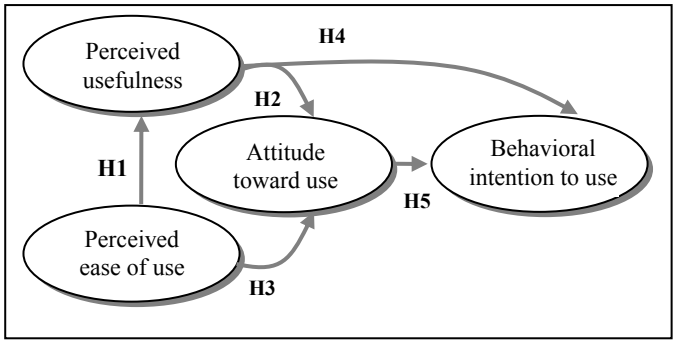
Based on the TAM model proposed by Davis (1989), we formulate the first working hypotheses of this research which make reference to the intrinsic constructs of the model. These hypotheses are stated in the following way:

- H1. PEU for OSS-ERP systems has a positive effect on PU.
- H2. PU for OSS-ERP systems has a positive effect on ATU.
- H3. PEU for OSS-ERP systems has a positive effect on ATU.
- H4. PU for OSS-ERP systems has a positive effect on BIU.
- H5. ATU for OSS-ERP systems has a positive effect on BIU.

4. RESEARCH MODEL AND DESIGN

The proposed research model, which is graphically displayed in Fig. 1, summarizes all the aforementioned formulated hypotheses. With such a model, we propose to uncover which factors influence the acceptance of OSS-ERP by users. In order to proceed in confirming the hypotheses, we have designed a field study as the necessary tool to obtain the information that would allow us to carry out this test. The election process of the sample and the instrument validity are detailed below.

Fig. 1. Research model and hypotheses



A. Sample

For our research, we have taken OSS-ERP users as the individuals that will form the sample for our study. We turned to Sourceforge website (http://sourceforge.net/index.php), where we were able to access to 703 contact information of the users that were registered in the OSS-ERP projects. Also, we have contacted with registered users in the forums and mailing list of the vendors Tiny ERP, ERP 5 and JFire. We sent an invitation letter by e-mail with the URL address where the questionnaire was published. In the end, we received 160 survey responses. Of those, 128 were complete and valid for our study. This number represents a response rate of 18.06%. The Table 1 shows the sample information.

Tabla 1: sample information

		N	%			N	%
Age	< 25	10	7.8125	**Gender**	Male	125	97.65625
	25-30	35	27.34375		Female	3	2.34375
	31-40	39	30.46875		Total	128	100
	41-50	27	21.09375	**Education**	Less than high school	2	1.5625
	51-60	13	10.15625		High school graduate	20	15.625
	>60	4	3.125		College/university graduate	51	39.84375
	Total	128	100		Master's	49	38.28125
					Ph.D.	6	4.6875
					Total	128	100

B. Survey design

In order to measure each one the variables included in the TAM model developed for our study (Fig. 1), we carried out a review of the literature that allowed us to identify items for each one of the constructs. We finally included 15 items in the survey (see Table 2).

A seven point Likert-type scale was used in the questionnaire from (1) ''strongly disagree'' to (7) ''strongly agree. This broad scale allows users a wide range of possible answers to correctly express their opinion and has been used in other studies similar to ours, for example Lee et al. (2007) utilized TAM to study from a user acceptance perspective about web-based negotiation support systems; Lee et al. (2007) examine the adoption of WebCT using TAM; Cheng et al. (2006a) investigates how customers perceive and adopt Internet banking developing a theoretical model based on TAM; or Cheng et al. (2006b) developed a study of consumer acceptance of the Internet as a channel of distribution in Taiwan using TAM.

Tabla 2: Items

Items	Source
PU1-Using the system in my job enabled to accomplish tasks more quickly. **PU2**-Using the OSS-ERP improves my performance in my job. **PU3**-Using the OSS-ERP in my job increases my productivity. **PU4**-Using the OSS-ERP enhances my effectiveness in my job.	Davis et al. (1989) Venkatesh and Davis (2000) Calisir and Calisir, 2004
PEU1-My interaction with the OSS-ERP systems is clear and understandable. **PEU2**-Interacting with the OSS-ERP does not require a lot of my mental effort. **PEU3**-I find the OSS-ERP to be easy to use. **PEU4**-I find it easy to get the systems to do what I want it to do.	Davis et al. (1989) Venkatesh and Davis (2000)
ATU1-The OSS-ERP will provide access to more data. **ATU2**-The OSS-ERP will make data analysis easier. **ATU3**-The OSS-ERP will be better than the old system. **ATU4**-The OSS-ERP will provide accurate information. **ATU5**-The OSS-ERP will provide integrated, timely and reliable information.	Davis et al. (1989) Amoako-G. and Salam (2004) Venkatesh and Davis (2000)
BIU1-I expect to use the new system. **BIU2**-I expect the information from the new system to be useful.	Davis et al. (1989) Amoako-G. and Salam (2004) Venkatesh and Davis (2000)

C. Instrument validity

Before conducting the main survey, we carried out a pre-test and a pilot test to validate the questionnaire. For the pre-test, various research experts in the application of TAM methodology revised the survey structure as well as its explanatory capability. They examined aspects such as the study invitation letter, the appropriateness of the questions and answers, the indications in each part of the survey and the survey length. Afterwards, a pilot test took place which included twenty-five OSS-ERP users.

Once the explanatory capability of the survey was verified, it was necessary to test that the selected items were capable of explaining the associated constructs. For this, Cronbach´s alpha test was applied to the groups of items for the constructs of the model, based on the data obtained in the pre-test (see Table 3). In our particular case, all the variables reached very satisfactory levels, going above the recommended level of 0.7 (Nunally and Bernstein, 1995). This circumstance demonstrates that the items are capable of measuring the variables for which they were selected. These results were expected, given the fact that the selected items were taken from similar studies whose predictive capability had been demonstrated.

Tabla 3: reliability coefficients

Construct	Cronbach's α
Perceived usefulness (PU)	0.983
Perceived ease of use (PEU)	0.887
Attitude toward use (ATU)	0.705
Behavioral intention to use (BIU)	0.918

5. PRELIMINARY ANALYSIS

Before proceeding to evaluate the validity of the scales proposed, we consider it appropriate to present a few of indexes used within descriptive statistics, such as (N), referring to the number of responses, mean and standard deviation (S.D.). Each one of the items conforms to the constructs in our study (see Table 4). This analysis has allowed us to reveal the averages for each one of the items included for each constructs in this study.

From the Table 4 we can appreciate the high response rate for all the items included in the study, all close to one-hundred percent. This information allows us to believe that the survey is easy to understand and that the participating users didn't have any difficulty in responding to the majority of the consulted variables. Likewise, we can say that the typical deviations are acceptable for all the variables considered.

Tabla 4: summary of measurement scales

Ítems	N	Mean	S.D.	Ítems	N	Mean	S.D.
PEU1	128	2.102	1.222	**BIU1**	128	1.688	1.209
PEU2	127	2.811	1.632	**BIU2**	128	1.570	1.284
PEU3	128	2.438	1.338	**ATU1**	126	1.778	1.226
PEU4	128	2.625	1.490	**ATU2**	126	1.857	1.319
PU1	127	1.945	1.274	**ATU3**	126	1.746	1.213
PU2	127	1.953	1.126	**ATU4**	125	1.824	1.115
PU3	126	2.024	1.249	**ATU5**	126	1.817	1.176
PU4	127	1.976	1.185				

6. ANALYSIS AND FINDINGS

In order to agree upon all the hypotheses collected in the investigational model, an exploratory factor analysis (EFA), a confirmatory factor analysis (CFA) and finally, a causal analysis have been developed. The statistical analysis of the causal model will be carried out with the software Liserl 8.51 (2001).

A. Exploratory factorial analysis.

The EFA was done to identify those items that had a strong impact on its constructs (Hair et al., 2000) as well as to reduce the number of items to be used in later analyses. This EFA was done separately for each one of the nine constructs included in our model and enabled us to make an analysis of the converging validity of these variables and its dimension.

The EFA was calculated using the SPSS 15.0 statistical software. The extraction method selected was Principal Axis Factoring, as this is the most appropriate method for identifying the constructs (Hair et al., 2000). We extracted those variables whose self-values were greater than one. Thus, we eliminated the factors which had a low factorial charge and whose exclusion from the study allowed us to obtain a Cronbach's alpha greater than the recommended minimum of 0.7 (Nunally and Bernstein, 1995). Likewise, the EFA (see Table 5) carried out for each one of the constructs of the model has been done by means of the Kaiser's Varimax Rotation in order to determine the unidimensionality of the scales (Kaiser, 1970; Kaiser and Rice, 1974).

Tabla 5: exploratory factor analysis

Construct	Items	Loading	Cronbach's α	Construct	Items	Loading	Cronbach's α
PU	PU1	0.924	0.965	**BIU**	BIU1	0.845	0.811
	PU2	0.943			BIU2	0.845	
	PU3	0.956		**ATU**	ATU1	0.857	0.914
	PU4	0.918			ATU2	0.884	
PEU	PEU1	0.780	0.881		ATU3	0.755	
	PEU2	0.728			ATU4	0.868	
	PEU3	0.927			ATU5	0.769	
	PEU4	0.824					

The EFA was able to demonstrate the unidimensionality of all the constructs in the study. Likewise, we can observe that the constructs perceived ease of use, perceived usefulness, behavioral intention to use, attitude toward use (see Table 5) far surpass the recommended minimum value with respect to Cronbach´s alpha of 0.7. Also, all items have a good factorial charge and for this reason we recommend taking them for testing the model.

B. Confirmatory factor analysis.

The CFA was carried out using the Lisrel structural equations software (34). This software has been used in other studies similar to ours, such as Lee et al. (2007), Pituch and Lee (2006), Yi et al. (2006), Lee et al. (2005), Luarn and Lin (2005) and Selim (2003).

The CFA was carried out using maximum likelihood robust statistical method. The evaluation of the adjustment is first carried out for the measurement model, verifying the statistical significance of each charge obtained among the indicator, the construct and the measurement reliability of each one of the constructs included in our model. The measurement analysis shows clearly that all standardized lambda coefficients are superior to the minimum value allowed of 0.5.

Regarding the discriminatory validity of the scales, our objective was to determine that each factor represents a separate dimension. This was done by means of the standardized linear or covariance correlations among the constructs. The results show discriminatory validity indexes among the different analyzed dimensions as they take values far from one (Bagozzi, 1994). Once the covariance correlations are squared, the variance quantity extracted became less and thus, we were then able to guarantee the discriminatory validity of the constructs. In order to study in depth this validity, we made sure that the correlation confidence interval between each pair of constructs didn't have a value of one, demonstrating that these factors represent notably different concepts (Anderson and Gerbing, 1988).

Once the discriminatory validity of the scales was demonstrated, and before proceeding to the CFA results interpretation, it was necessary to determine the adjustment fits of the estimated model, using the indexes indicated in Table 6. The indicators used went above the maximum limits established by Hairet al. (2000).

Tabla 6: overall fits of models

Fit index	Results	Recommended value
Chi-square/grade of freedom	1.47	≤3.00
Normed fit index (NFI)	0.917	≥0.90
Non-normed fit index (NNFI)	0.965	≥0.90
Comparative fit Index (CFI)	0.971	≥0.90
Adjusted goodness-of-fit index (AGFI)	0.834	≥0.80
Root mean square error of approximation (RMSEA)	0.048	≤0.05
Goodness-of-fit index (GFI)	0.903	≥0.90
Incremental fit index (IFI)	0.972	≥0.90
Parsimony Normed Fit Index (PNFI)	0.742	>0.5

Upon verifying the discriminatory validity of the scales and the model adjustment fit, the CFA of the whole model was carried out showing an adequate specification of the proposed factorial structure in the results (see Table 7).

The proposed reliability of the measurement scales was evaluated from the Cronbach´s alpha and Composite Reliability (Cr) coefficients (Bagozzi and Yi, 1988). We declare that a model possesses internal consistency when the composite reliability reaches values greater than 0.7 for all the constructs defined in the model.

In order to estimate the discriminatory validity of the model, we have calculated the average variance extracted (AVE) proponed by Fornell and Larcker (1981). On one hand, the standardized factorial charges are statistically significant, around 0.7 and with individual reliabilities at or above 50%. This demonstrates the converging validity of the measurement scales. This information, together with the strong Cronbach alpha, provides sufficient evidence for the internal consistency of the measurements (Hair et al., 2000). Besides, all constructs surpass the recommended AVE value of 0.5 (see Table 7) and all AVE square roots surpass the correlations with the rest of the constructs.

Tabla 7: summary of measurement scales

Construct		Lambda stand.	R2	C. reliability	AVE	Cronbach's α
PEU	PEU1	0.790	0.624	0.893	0.676	0.899
	PEU2	0.773	0.598			
	PEU3	0.859	0.738			
	PEU4	0.841	0.743			
PU	PU1	0.881	0.776	0.952	0.832	0.966
	PU2	0.968	0.937			
	PU3	0.934	0.872			
	PU4	0.862	0.743			
BIU	BIU1	0.923	0.852	0.861	0.756	0.873
	BIU2	0.813	0.661			
ATU	ATU1	0.829	0.687	0.901	0.645	0.914
	ATU2	0.831	0.691			
	ATU3	0.773	0.598			
	ATU4	0.803	0.645			
	ATU5	0.779	0.607			

7. MODEL HYPOTHESES CONTRAST

The research models were tested by structural equation modeling (SEM) using Lisrel 8.51 with maximum-likelihood estimation. The parameters that represent the regression coefficients among the constructs are indicated with the symbol β.

$$PU = \beta 1\ PEU + \varepsilon 2$$

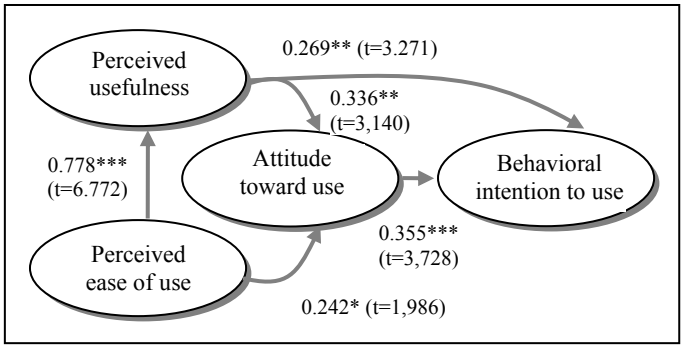
$$ATU = \beta 2\ PEU + \beta 3\ PU + \varepsilon 3$$

$$BIU = \beta 4\ ATU + \beta 5\ PU + \varepsilon 4$$

For the Lisrel application the t-student statistics were reached which allowed support for each one of the formulated hypothesis in the study (Fig. 2). In addition, this software permitted us to quantitatively define the strength of each one of the relationships among the constructs defined in the model, which ever one they corresponded to.

Regarding the significance level of each relationship among the constructs of the TAM model, its t-student statistic, we can claim that this relationship has been significantly confirmed in all cases. All hypotheses were tested significantly for p <0.05*, p <0.01**, p <0.001*** (based on t(499); t(0.05;499) = 1.967007242; t(0.01; 499) = 2.590452926; t(0.001;499) = 3.319543035) and the findings support the causal relationships proposed in the research model (Anderson and Gerbing, 1988).

Fig. 2. Research model and hypotheses



In this sense, the high significance of the relationship posed in hypothesis H1 between the perceived ease of use and the perceived usefulness (β=0.778, p<0.001) is fulfilled. Likewise, hypothesis H2, dealing with the perceived usefulness and the Attitude toward use, has been confirmed with a high level of significance (β=0.336, p<0.01). Turning to hypothesis H3, we can observe the significant support of the perceived ease of use with that of the Attitude toward use (β=0.242, p<0.05). In hypothesis H4 we are able to state the significance of the effect that the perceived usefulness has on the behavioral intention to use of the OSS-ERP (β=0.269, p<0.01). Finally, the effect that the Attitude toward use an OSS-ERP has on the behavioral intention to use has been verified in hypothesis H5 (β=0.355, p<0.001).

Moreover, we were able to prove how the model very adequately explains the variance in perceived usefulness (R2=0.415), Attitude toward use (R2=0.293) and behavioral intention to use (R2=0.378). Based on these results, we can state the research model defined satisfactorily explains the intentions of the OSS-ERP use as far as the final users are concerned. The variability reached for the attitude toward use the OSS-ERP (28.1%) can be considered significant compared to other studies that apply the TAM model in the IS field. This can be seen, for example, in the studies done by Amoako-Gyampah and A.F. Salam (2004) with a R2 of 0.288 for the intentions

to use an ERP system of SAP and by Saade´ and B. Bahli (2005) with a R2 of 0.26 related to the intention to use IS for e-learning.

8. DISCUSSIONS

From a theoretical point of view, these findings confirm the applicability of TAM to explain the users' acceptance of OSS-ERP systems. All the relationships proposed by TAM have been tested satisfactorily. In this sense, this study contributes evidence about OSS-ERP systems acceptance.

From a practical point of view, we can observe some relevant implications for organizations and practitioners that could highlight the utility of management resources for OSS-ERP acceptance. First, organizations would have to involve potential users in the main stages of the OSS-ERP implantation project with the intention of reaching a successful implementation. Second, in order to stimulate an adequate use of OSS-ERP, organizations and users would have to select OSS-ERP which is useful and easy to use. Third, based on our findings, OSS-ERP solutions for organizations seem to be a viable alternative front to ERP proprietary software, especially for SMEs.

Finally, our findings highlight the necessity of continuing with research about this topic. Specifically, we could start future work based on these findings. First, we are interested in analyzing how affect the behavioral intention to use an OSS-ERP system factors such as technological complexity, training, organizational communication and top management support. Second, we consider that it would be interesting to develop future research to analyze OSS-ERP acceptation after completing an implementation in a particular organization.

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