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Greek Agricultural Processing Industries: Relationships between Critical Success Factors and Enterprise Resource Planning implementation

Asimina Kouriati, Christina Moulogianni, Thomas Bournaris *, Eleni Dimitriadou and Stefanos A. Nastis

Department of Agricultural Economics, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece
* Correspondence: tbournar@agro.auth.gr; Tel.: +30-231-099-8423

Abstract: This study aims to identify the relationships between critical factors and successful Enterprise Resource Planning implementation in the agricultural processing companies of Central Macedonia's (Greece) region. Therefore, critical factors are taken into account collectively, as aspects of ERP implementation and its life cycle. Based on that, two versions of the particular information system's management were presented, aiming to its success in the Greek agricultural processing field. The methodology which was used in order for the purposes of this analysis to be served, was that of Partial Least Squares Structural Equation Modeling. Through the answers given, it was determined whether the importance shown to the two different versions of critical factors is related to the degree of ERP systems' success—or not—and in which way. Based on that, two management versions of ERP system are provided but also the scientific literature regarding the Greek and Central Macedonian field, is enriched. Lastly, helpful guidelines are developed in order for professionals and managers to understand the ways in which critical factors can be taken into account so as for the successful implementation of ERP in agribusinesses -specialized in the field of agricultural products processing- to be feasible.

Keywords: ERP; critical success factors; agricultural products processing companies; central macedonia; Greece

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1. Introduction

ERP system became one of the largest investments in information technology field during 90's [1] and it has been installed in thousands of companies worldwide since then [2]. The main ambition of an ERP system is the integration of the whole range of the departmental functions of a company in a computer system [3]. These functions, in particular, refer to finance and accounting, planning, processing, sales, marketing, human resource management, distribution, and transportation areas which are being monitored through a software solution such as ERP [4]. Therefore, it could be concluded that the ERP system enables a timely decision-making process, which makes it a strategic tool that leads to operational excellence and provides a variety of competitive advantages [5].

Apart from the popularity of this system, the failure rate of ERP implementation is high [4]. This is something that led several researchers to factors' identification, which may enhance the whole implementation process [5]. ERP success is defined by information quality, system quality and service quality [6–9]; parameters which are also defined in the literature as critical success factors [10]. Sangster [11], though, argued that the success of an ERP system is based on the perception of those who are involved in its implementation. If the ERP implementers consider that they do not receive the information they need from the system in order to manage their tasks, then, the ERP implementation is considered unsuccessful. On the other hand, if they consider that they receive detailed reports that help them to cover operational areas in real time, then, the implementation of the system is deemed successful [11]. The parameters, that are believed to increase the possibilities of the ERP system's success, are known as critical success factors [12]. The understanding of CSFs and the way in which they affect ERP implementation lead to the reduction of failure risk and the provision of useful business guidance [12,13].

Identifying the relationships between critical factors and the success of ERP systems in various companies [14–17] evinces deep interest [18]. This fact led the authors to identify the properties of corresponding relationships in agricultural processing companies since similar Greek research implementations lack literature references. To be more precise regarding this specific research field, the study of [18] identified the relationship between Critical Success Factors (CSFs) and ERP success in Central Macedonian agricultural processing companies by taking into account the CSFs individually, as features of the system and its implementation.

> *However, what happens in case the factors are not taken into account individually, but* ***collectively****, and, even, as* ***dimensions of ERP implementation*** *(Organization, Human, Project factors, Extertnal partners' and Technology) and* ***its life cycle*** *(Pre-implementation, Implementation, Post-Implementation phases), as they are defined by the theoretical framework of [10]?*

This is a question that led the present study's authors to a further investigation in order to identify more of these relationships properties. For this purpose, it was decided that this paper should be the continuation of previous works of Kouriati et al. [10,18,19]. In these papers, 37 ERP critical success factors were identified through content analysis [10], also these factors were evaluated by a group of stakeholders [19], and finally the critical factors and ERP success relationships were investigated individually in agricultural processing companies that are located in the prefecture of Central Macedonia [18].

In this paper, the 37 critical factors are taken into account: "collectively, as aspects of ERP implementation and its life cycle" [10]. Based on this, two more management versions (ERP implementation and ERP life cycle) of this information system are presented, aiming to its success in Greek agribusinesses specialized in the field of agricultural products processing.

The remainder of this paper is structured as follows: (1) A literature review in which previous studies -that relate to the present study's framework- are presented (Section 2), (2) Presentation of the material and methods used where the research questionnaire, SEM method and research hypotheses are descripted in depth (Section 3), (3) Analysis results (Section 4) and discussion (Section 5), disclosure of the conclusions drawn, limitations and contribution (Section 6).

2. Literature Review

In this section, an overview of previous studies that have a similar subject to that of the present study will be carried out. Some of the studies of the related literature study the relationships between Critical Factors and ERP success in various economic sectors [5,14,20–23] but, specifically, less in the sector of agriculture [15,18].

Lakshmanan et al. [21] identified a number of Critical Success factors in order to identify their effect on ERP implementation in the sector of the Indian automobile ancillary industries. The critical factors are identified through a literature review and ERP professionals, were then interviewed in order for empirical data to be collected. By using correlation analysis was revealed that "training and development", "advanced software and hardware", "project management", "change management", and "top management support" present high correlation coefficients both with each other and with ERP implementation [21]. These results helped [21] to provide helpful comments to ERP stakeholders in the automotive ancillary industries. Similar research studies in various sectors of economy were those of [14,20].

Another related study is that of [5] in Greek SMEs. Chatzoglou et al. [5], initially investigated 9 critical factors through a literature review, and then, using a questionnaire, empirical data were collected from IT managers. These data were then statistically analyzed using Structural Equation Modeling (SEM) [5]. The results showed that 6 critical factors have a significant impact on the implementation of ERP systems which in turn affects organizational efficiency [5]. Similar research applications are also the studies of [22,23].

In the field of agriculture, a similar methodological approach is followed to this specific research issue. For example, [15] aimed to examine the relationship between Critical Success Factors and ERP implementation in a dairy products company which is located in Iran. Using the structural equation model method and the Friedman test, they showed the influence degree for each of the factors on the successful implementation. Kouriati et al. [18], taking into account 37 Critical Factors -from [10]'s theoretical background- studied their relationships with ERP successful implementation in Central Macedonian agricultural processing companies. Collecting data from 157 companies and implementing Correlation Analysis method showed that the ERP users' importance indication to 24 CSFs is positively related to ERP success degree. Kouriati et al. [18], studied and analyzed statistically these factors through correlation analysis because they desired to create a model by which the Critical Factors are taken into account from ERP users individually, as features of the implementation and the system.

At this point, the main research question (mentioned in Section 1) is essentially understood because it is made clear that concerns the collective approach of the critical factors for ERP success in agricultural processing industries. The collective approach refers specifically to the dimensions of the system's implementation (Human factors, Organizational factors, Project factors, External partners' factors, and Technological/ERP factors) and its life cycle (Pre-implementation factors, Implementation factors, and Post-implementation factors) as [10] provided by making a categorization analyses through the help of various literature studies [6,15,23–29].

Therefore, the present study's authors decided to identify the relationships between Critical Factors and ERP successful implementation in Greek Agricultural Industries -as a continuation of [10,18,19]- in order for this management point of view to be provided but also the scientific literature regarding the Greek and Central Macedonian field, to be enriched. According to a set of literature studies as [5,15,18,19,22,23,30–32], it was decided to conduct relative research on ERP stakeholders and their preferences to critical factors' importance and system's success. The statistical analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) [5,15,22,23,30–33] method. Through this method, relative conclusions were stated in order for professionals and managers to understand the ways in which critical factors can be taken into account so as for the successful implementation of ERP in agribusinesses -specialized in the field of agricultural products processing- to be feasible.

3. Materials and Methods

Primary research was conducted on agricultural processing industries, which are located in the areas of Central Macedonia's region (Greece). Central Macedonia is one of the 13 Greek regions and is consisted of 7 regional units (Thessaloniki, Chalkidiki, Pieria, Imathia, Pella, Kilkis and Serres). According to [19] it is claimed that a large number of agricultural products processing industries are located in these regional units and are engaged in the processing of milk, olives, fruits, nuts, meat, vegetables, bee products, cereals, wheat, coffee and tea. The research tool used was a specially designed questionnaire that was formed after an extended literature review [8,11,12,15,34–39]. The questionnaire was distributed electronically to the corporate e-mails of industries that are located in the 7 regional units of Central Macedonia. The reason that this survey was conducted electronically is that the real number of the Central Macedonia's agricultural processing industries could not be calculated. At this point, it should be mentioned that the electronic questionnaire use is something approved from a big range of the relative literature [5,12,23,40]. Primary research data were collected from October 2019 to February 2020. The questionnaire was sent to 1008 industries but 227 ERP user of 157 industries completed it and sent it back.

Regarding the questionnaire form, its parts are related to the critical factors and ERP implementation success [18,19]. Both of these parts were formatted on Likert scale [11,12] developing questions for the respondents in order to point out their preferences: (1) to the importance degree of critical factors (1 = Not Important, 2 = Shortly Important, 3 = Moderate important, 4 = Important and 5 = Very Important) and (2) to the degree of ERP success (1 = Not at all, 2 = Only a little, 3 = To some extent, 4 = Rather much, and 5 = Very much) [18,19]. After the data collection, Partial Least Squares Structural Equation Modeling (PLS-SEM) [5,15,22,23,30–33] was implemented in order for the relationships between implementation success and critical factors, which are taken into account as dimensions of ERP implementation and its life cycle, to be respectively identified.

Structural Equation Modeling (SEM) allows researchers to examine complex and different relationships in a single analysis and offers the possibility of testing research models with various dependent variables [41]. One of the best known SEM's approaches is that of Partial Least Squares, which is mainly chosen when there is minimum theory on the issue and uncertainty about the correct model specification, the sample of a survey is small and the data are unevenly distributed [42–45]. It is a theoretical model estimation with the use of PLS-SEM, which is based on a three-stage approach that belongs to the (alternating) least squares algorithms' family (PLS-SEM algorithm) [46,47]. PLS-SEM algorithms constitute a regression sequence for the weights (w) of indicators. Namely, the contribution of x variables to a latent variable Y.

PLS-SEM algorithm results aim to the formative model assessment that concludes the evaluation of: (1) indicator collinearity, (2) convergent validity, (3) statistical significance and indicator weights' relevance [47]. The first two ways constitute the estimation of the measurement model, that is, the way in which the indicators of each latent variable explain its variation. The third way constitutes the estimation of the structural model, whose relationships between the latent variables are checked. Collinearity assessment is performed by calculating the VIF (Variance Inflation Factors) values for each formative indicator of the model. VIF is calculated through the PLS-SEM algorithm by performing a multiple regression of each formatively latent variable's indicator (construct) with the rest of its items [47]:

$$\text{VIFk} = \frac{1}{1 - Rk^2} \quad (1)$$

If the VIF value is greater than 3.3, then the possibility of collinearity becomes apparent and it is rejected [48]. The bootstrapping technique is used to check the convergent validity so as for the outer weights and outer loadings to be calculated and, then, compared in terms of size and statistical significance in order to prove the case of non-validity of the measurement model [47,49–51].

Once the model is revised and the conditions of the measurement model are confirmed, the analysis proceeds to the structural model's assessment [32,47], which includes the corresponding collinearity assessment and the estimation of coefficients R^2 and f^2 (effect size). Collinearity assesment is achieved by considering exogenous latent variables, which affect the endogenous, as indicators. This measure is calculated through the PLS-SEM algorithm and there is no collinearity problem if values of the VIF measure are lower than the limit (<3.3) [52]. Coefficient of determination R^2 indicates the explained variance in each one of the endogenous constructs and ranges between 0 and 1 [50]. There is not any general rule as regards the values that R^2 can take in order for it to be considered satisfactory. Therefore, several researchers have set different limits [48,53], even to different implemetation contexts. Chin [54], for example, has set the values of 0.67, 0.33 and 0.19 as limits, which are considered more realistic in most of the implementation contexts.

R^2, due to the fact that it has many weaknesses as a coefficient, is adjusted (Adjusted R^2) so as for the interpretive variables' number of each one of the model's endogenous variables to be negatively taken into consideration. Adjusted R^2 differs from R^2 essentially, given that it does not discriminate in favor of models that have more variables [48,50,55]. Values of R^2 and Adjusted R^2 result from the application of the bootstrapping technique as well as f^2, which concerns the estimation of the effect size that a variable has on another one and expresses the degree to which the removal of an independent variable leads to R^2 reduction [55]:

$$f^2 = \frac{R^2_{\ included} - R^2_{excluded}}{1 - R^2_{\ included}} \tag{2}$$

$R^2_{excluded}$ and $R^2_{included}$ refer to the R^2 values of the endogenous latent variable when a specific predictor construct is excluded from the model or included in it respectively [47]. According to Cohen in [55], the values of 0.02, 0.15 and 0.35 correspond to small, medium and large effect and are set as limits of f^2 coefficient. The estimation of the structural model is completed with research hypotheses testing, which T and *p* values of direct, indirect and total effects coefficients for each one of the structural model's causal relationships are extracted from. These estimations are made by using the bootstrapping technique and the possibility of whether they differ significantly and statistically from zero—or not—is assessed. In this case, if T value corresponds to a probability less than the significance level ($p < 0.1$, $p < 0.05$, $p < 0.01$), then the null hypothesis for association lack is rejected. Total effect coefficients refer to the sum of direct and indirect effect of all variables. This estimation provides a complete picture of the structural model's causal relationships. In case mediating variables (indirect effect coefficient) do not exist, then total effect is directly explained by the direct effect coefficient, as they are equal.

As it was already mentioned, the present survey was conducted by sending an electronic questionnaire and lasted four months (October 2019–February 2020). A total of 227 members of 157 industries, which are engaged in the processing of agricultural products participated in it. After the data collection, data were properly formulated and entered the statistical package of Smart Pls3 [51]. 8 research hypotheses were created; 5 about the dimensions of ERP implementation and 3 about its life cycle [10]. In the first case, the resulting research hypotheses are formulated as follows:

1. The importance that is indicated to organizational factors is significantly related to the degree of ERP system's implementation success.
2. The importance that is indicated to project factors is significantly related to the degree of ERP system's implementation success.
3. The importance that is indicated to human factors is significantly related to the degree of ERP system's implementation success.
4. The importance that is indicated to technological/ERP factors is significantly related to the degree of ERP system's implementation success.
5. The importance that is indicated to external partners' factors is significantly related to the degree of ERP system's implementation success.

Organizational factors are related to company's structure, general administration, processes, business goals, and environment while project factors concern a group of people who supervise the system's implementation [10]. Human factors are associated with ERP users' skills and characteristics, and technological/ERP factors are related to system's functionality and characteristics [10]. Lastly, external partners' factors concern a set of factors that emphasizes the relationship between company, ERP, and external partners [10]. The above research hypotheses are considered alternative, while, in this case, the null hypotheses are set as ***H_{02}*****: The importance that is indicated to each dimension of the system's implementation is not significantly related to the degree of ERP system's implementation success.*** These research hypotheses testing will indicate what happens if factors are taken into account by industries collectively, as dimensions of ERP implementation. Additionally, appropriate advice will be given so as for the field of agricultural products processing to be completed.

Similarly, if critical factors (i.e., their importance values) are taken into account collectively, as dimensions of ERP life-cycle [10], the research hypotheses will be formulated as follows:

1. The importance that is indicated to pre-implementation phase factors is significantly related to the degree of ERP system's implementation success.
2. The importance that is indicated to implementation phase factors is significantly related to the degree of ERP system's implementation success.
3. The importance that is indicated to post-implementation phase factors is significantly related to the degree of ERP system's implementation success.

Pre-implementation phase factors related to the company's preparation processes for an ERP system's acquirement [10]. Implementation phase factors are associated with project activities and organization, software testing, configuration, stabilization and eventually the ERP implementation [10]. Lastly, post-implementation phase factors are related to upgrading, maintenance and further training activities. These activities last until the system is replaced [10].

The null hypotheses, which are defined in this case, are set as: ***H_{03}: The importance that is indicated to each dimension of the system's life cycle is not significantly related to the degree of ERP system's implementation success.*** These research hypotheses testing will indicate what happens if the factors are taken into account collectively, as dimensions of the ERP life cycle. Additionally, appropriate advice will be given so as for the field of agricultural products processing to be completed.

4. Results

4.1. Relationships between ERP Success and Critical Factors as Dimensions of the System's Implementation

During the model's formulation, based on the dimensions of ERP implementation, the importance values of critical factors were set as formative indicators [30,33] and their categories as the latent variables [10], which are, also, the independent variables of the model. The latent variable, which is composed of the ERP system's implementation success degree, is the dependent variable.

Initially, a collinearity assesment was performed, the results of which showed that there is no relevant problem regarding the critical factors' indicators (VIF < 3.3) [52] (Table 1).

Table 1. Collinearity assesment in the measurement model (Dimensions of ERP implementation).

Critical Factors—Formative Indicators	VIF
Accuracy, Quality and Data Integrity	2.199
Business Process Re-engineering	1.913
Well defined Budget of Project	2.144
Business plan, goals, scope, mission and vision	1.859
Change management	2.280
Users' characteristics, skills and capabilities	1.586
Communication plan	1.784
Communication, collaboration and trust	1.328
External pressure	1.826
Company-Wide Support and Commitment	1.411
Use of consultants	2.251
Existence of empowered decision-makers	2.236
ERP package selection	2.186
ERP vendor selection	1.430
IT Infrastructure/Business and IT legacy systems	1.921
Implemented modules	1.615
Knowledge management	2.015
Minimum customization ERP	1.577
Monitoring, Evaluation and Feedback	1.871

Table 1. *Cont.*

Critical Factors—Formative Indicators	VIF
National culture	1.536
Organizational culture	1.794
Users and stakeholders' involvement	1.587
Presence of project champion and adequate role	1.912
Project management	1.974
Composition of a capable and balanced project team	2.141
Controlled ROI on ERP implementation	2.031
Realistic expectations	1.880
Recognition of qualifications, reward and motivation	1.890
Service Quality	2.147
Implementation strategy and goals achievement timeframe	2.240
Post-implementation audit	2.245
System Quality	2.744
ERP, business and business processes alignment	2.380
System support/Maintenance and further training	2.780
Software testing, customization and troubleshooting	1.720
Training	1.427
Top management support and commitment	1.212

Consequently, the convergent validity evaluation was performed, which the following results were extracted from (Table 2).

Table 2. Convergent validity evaluation (Dimensions of ERP implementation).

S/N	Causal Relationship	Item Weight	Item Loading	Sample Mean	STDEV	T Statistics
SERO1	Accuracy, Quality and Data Integrity → Technological/ERP factors	0.410	0.578	0.375	0.191	2.148 **
SERO2	ERP package selection → Technological/ERP factors	0.584	0.594	0.515	0.186	3.132 **
SERO3	IT Infrastructure/Business and IT legacy systems → Technological/ERP factors	−0.276	0.287	−0.246	0.206	1.342 *
SERO4	Implemented modules → Technological/ERP factors	0.868	0.799	0.781	0.172	5.044 ***
SERO5	Minimum customization → Technological/ERP factors	−0.166	0.268	−0.150	0.178	0.933 **
SERO 6	Post-implementation audit → Technological/ERP factors	−0.150	0.369	−0.128	0.227	0.662 **
SERO7	System Quality → Technological/ERP factors	−0.365	0.351	−0.335	0.229	1.592 **
SERO8	ERP, business and business processes alignment → Technological/ERP factors	−0.373	0.357	−0.343	0.277	1.345 **
SERO9	System support/Maintenance and further training → Technological/ERP factors	0.324	0.501	0.291	0.234	1.387 ***
SER10	Software testing, customization and troubleshooting → Technological/ERP factors	0.012	0.367	0.028	0.209	0.056 **
SER11	Business Process Re-engineering → Organizational factors	0.089	0.559	0.088	0.182	0.493 ***
SER12	Well defined Budget of Project → Organizational factors	0.421	0.697	0.353	0.181	2.332 **
SER13	Business plan, goals, scope, mission and vision → Organizational factors	0.077	0.470	0.073	0.220	0.352 **
SER14	Change management → Organizational factors	0.424	0.600	0.353	0.188	2.257 **
SER15	Communication plan → Organizational factors	−0.235	0.386	−0.201	0.190	1.232 **
SER16	Communication, collaboration and trust → Organizational factors	0.302	0.475	0.272	0.192	1.569 **
SER17	External pressure → Organizational factors	0.644	0.698	0.554	0.173	3.731 ***

Table 2. *Cont.*

S/N	Causal Relationship	Item Weight	Item Loading	Sample Mean	STDEV	T Statistics
SER18	Knowledge management → Organizational factors	−0.357	0.278	−0.303	0.213	1682 *
SER19	National culture → Organizational factors	−0.259	0.289	−0.237	0.185	1.398 *
SER20	Organizational culture → Organizational factors	0.094	0.506	0.068	0.211	0.446 ***
SER21	Controlled ROI on ERP implementation → Organizational factors	0.073	0.541	0.061	0.203	0.359 ***
SER22	Realistic expectations → Organizational factors	−0.025	0.369	−0.025	0.208	0.120 **
SER23	Implementation strategy and goals achievement timeframe → Organizational factors	−0.071	0.568	−0.039	0.253	0.280 ***
SER24	Users' characteristics, skills and capabilities → Human factors	−0.027	0.404	−0.025	0.244	0.111 **
SER25	Company-Wide Support and Commitment → Human factors	−0.197	0.274	−0.185	0.243	0.811
SER26	Users and stakeholders' involvement → Human factors	0.568	0.667	0.532	0.261	2.174 **
SER27	Training → Human factors	−0.119	0.245	−0.113	0.225	0.531
SER28	Top management support and commitment → Human factors	0.815	0.877	0.741	0.175	4.662 ***
SER29	Use of consultants → Extertnal partners' factors	0.453	0.862	0.392	0.532	0.851 ***
SER30	ERP vendor selection → Extertnal partners' factors	0.553	0.872	0.473	0.339	1632 ***
SER31	Service Quality → Extertnal partners' factors	0.167	0.763	0.146	0.521	0.320 ***
SER32	Existence of empowered decision-makers → Project factors	−0.415	0.236	−0.383	0.286	1.451
SER33	Monitoring, Evaluation and Feedback → Project factors	0.875	0.817	0.765	0.254	3.447 ***
SER34	Presence of project champion and adequate role → Project factors	−0.370	0.263	−0.313	0.283	1.306
SER35	Project management → Project factors	0.581	0.640	0.521	0.277	2.099 **
SER36	Composition of a capable and balanced project team → Project factors	−0.267	0.218	−0.217	0.271	0.984
SER37.	Recognition of qualifications, reward and motivation → Project factors	0.371	0.450	0.340	0.298	1.244 **

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The levels of statistical significance were chosen to be 0.1, 0.05 and 0.01. The audit showed that 5 out of 37 critical factors do not meet the validity requirements and should be removed (dark markings) [47,49,50]. Once the factors, which did not fulfill the validity requirements, were removed, then the model was revised, the conditions of the measurement model (collinearity, validity) were confirmed and the analysis proceeded to the estimation of the structural model. During the collinearity assessment, the fact that there is no relevant problem emerged (VIF < 3.3) (Table 3).

Table 3. Collinearity assesment in the structural model (Dimensions of ERP implementation).

Exogenous Variables	Degree of ERP System Success
Human factors	1.700
Organizational factors	1.664
Project factors	1.513
Extertnal partners' factors	1.671
Technological/ERP factors	1.313

Through the use of bootstrapping technique in a number of 5000 subsamples, it turned out that R^2 is equal to 0.236, which is something that puts emphasis on the fact that the changes in the importance of critical factors explain the 23.6% of the variability of the ERP success degree. This percentage indicates weakness to moderate the model's adaptability [34], although R^2 turned out to be statistically different from zero, which is something that highlights the existence of the model's adaptability (Table 4).

Table 4. R^2 and Adjusted R^2 of the model (Dimensions of ERP implementation).

Endogenous Variable	R^2	Sample Mean	Standard Deviation	T Statistics	*p* Values
Degree of ERP system success	0.236	0.301	0.052	4.563	0.000
Endogenous Variable	**Adjusted R^2**	**Sample Mean**	**Standard Deviation**	**T Statistics**	***p* Values**
Degree of ERP system success	0.218	0.285	0.053	4.135	0.000

In case that Adjusted R^2 is taken into account, the resulting percentage is equal to 21.8%, which is slightly lower than that of R^2. Through bootstrapping technique (5000 subsamples), the values of f^2 (effect size) for each causal relationship of the model were obtained (Table 5).

Table 5. f^2 (effect size) for the model's causal relationships (Dimensions of ERP implementation).

Causal Relationships	f^2	Sample Mean	Standard Deviation
Human factors → Degree of ERP system success	0.011	0.012	0.013
Organizational factors → Degree of ERP system success	0.053	0.090	0.042
Project factors → Degree of ERP system success	0.003	0.008	0.009
Extertnal partners' factors → Degree of ERP system success	0.021	0.014	0.015
Technological/ERP factors → Degree of ERP system success	0.083	0.098	0.042

The limits of coefficient f^2 are the values 0.02, 0.15 and 0.35, which correspond to small, medium and large effect [55]. Thus, it is pointed out that the importance of technological/ERP (f^2 = 0.083), organizational (f^2 = 0.053) and external partners' (f^2 = 0.021) factors slightly and/or moderately affects the degree of the successful implementation of ERP. The effect of human (f^2 = 0.011) and project factors (f^2 = 0.003) is zero. Subsequently, the research hypotheses were tested using the bootstrapping technique, which T and *p* values of the path coefficients for each causal relationship were derived from (Table 6).

In the context of the present analysis, mediating variables do not exist and, therefore, the direct effect coefficient is taken into account (Original Sample values). The levels of statistical significance were chosen to be those of 0.1, 0.05 and 0.01. Thus, it appears that, apart from the factors that are related to the Project (T = 1.019, p = 0.308), which null hypothesis (H_{02}) is accepted for, there are relationships between the importance that is shown in the respective factors' categories, regarding ERP implementation, and the degree of success. With regard to the kinds of the relationships, external partners' factors show a negative relationship with the degree of the ERP system's implementation success, while the rest of the dimensions indicate a positive one.

Table 6. Path Coefficients, *p* and T values for the model's causal relationships (Dimensions of ERP implementation).

Causal Relationships	Original Sample	Sample Mean	Stndrd Deviation	T Statistics	*p* Values
Human factors → Degree of ERP system success	0.121	0.097	0.067	1.797	0.072 *
Organizational factors → Degree of ERP system success	0.260	0.301	0.065	4.025	0.000 ***
Project factors → Degree of ERP system success	0.063	0.063	0.063	1.010	0.313
Extertnal partners' factors → Degree of ERP system success	−0.166	−0.100	0.074	2.241	0.025 **
Technological/ERP factors → Degree of ERP system success	0.289	0.295	0.060	4.789	0.000 ***

*$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Relationships between ERP Success and Critical Factors as Dimensions of the System's Life Cycle

At this point, a corresponding analysis was decided to be made in order for the relationships between successful implementation and ERP life cycle dimensions to be investigated. During the model's formulation, the importance values of critical factors are set as formative indicators and the categories of ERP life-cycle [10] as latent variables.

Collinearity assesment showed that there is no relevant problem in the indicators of critical factors (VIF < 3.3) (Table 7).

Table 7. Collinearity assesment in the measurement model (Dimensions of ERP life-cycle).

Critical Factors—Formative Indicators	VIF
Accuracy, Quality and Data Integrity	2.025
Business Process Re-engineering	2.055
Well defined Budget of Project	2.260
Business plan, goals, scope, mission and vision	1.906
Change management	2.209
Users' characteristics, skills and capabilities	1.991
Communication plan	1.549
Communication, collaboration and trust	1.601
External pressure	1.968
Company-Wide Support and Commitment	1.975
Use of consultants	1.688
Existence of empowered decision-makers	2.415
ERP package selection	1.888
ERP vendor selection	1.896
IT Infrastructure/Business and IT legacy systems	1.656
Implemented modules	1.890
Knowledge management	2.112
Minimum customization ERP	1.577
Monitoring, Evaluation and Feedback	1.378
National culture	1.603
Organizational culture	1.472
Users and stakeholders' involvement	2.147
Presence of project champion and adequate role	2.098
Project management	2.036
Composition of a capable and balanced project team	1.698
Controlled ROI on ERP implementation	2.163
Realistic expectations	2.003
Recognition of qualifications, reward and motivation	1.961

Table 7. *Cont.*

Critical Factors—Formative Indicators	VIF
Service Quality	1.880
Implementation strategy and goals achievement timeframe	2.171
Post-implementation audit	2.021
System Quality	2.691
ERP, business and business processes alignment	2.136
System support/Maintenance and further training	1.803
Software testing, customization and troubleshooting	2.164
Training	1.629
Top management support and commitment	1.795

Through the convergent validity evaluation, it emerged that 2 factors do not meet the validity requirements and should be removed (dark markings) [47,49,50]. These 2 factors belong to the category of system implementation phase (Table 8).

Table 8. Convergent validity evaluation (Dimensions of ERP life-cycle).

S/N	Causal Relationships	Item Weight	Item Loading	Sample Mean	Standard Deviation	T Statistics
SERO1	Business Process Re-engineering → Pre-implementation phase factors	0.075	0.459	0.069	0.158	0.472 ***
SERO2	Well defined Budget of Project → Pre-implementation phase factors	0.256	0.572	0.212	0.168	1.529 ***
SERO3	Business plan, goals, scope, mission and vision → Pre-implementation phase factors	0.108	0.386	0.095	0.161	0.670 **
SERO4	Change management → Pre-implementation phase factors	0.368	0.493	0.316	0.163	2262 ***
SERO5	Communication, collaboration and trust → Pre-implementation phase factors	0.140	0.390	0.132	0.146	0.959 **
SERO6	External pressure → Pre-implementation phase factors	0.390	0.573	0.342	0.146	2.680 ***
SERO7	Use of consultants → Pre-implementation phase factors	−0.055	0.321	−0.037	0.143	0.381 **
SERO8	ERP package selection → Pre-implementation phase factors	0.409	0.479	0.361	0.153	2675 ***
SERO9	ERP vendor selection → Pre-implementation phase factors	−0.186	0.325	−0.172	0.151	1.234 **
SER10	IT Infrastructure/Business and IT legacy systems → Pre-implementation phase factors	−0.251	0.231	−0.212	0.139	1.807 *
SER11	Implemented modules → Pre-implementation phase factors	0.507	0.644	0.453	0.141	3588 ***
SER12	Knowledge management → Pre-implementation phase factors	−0.350	0.228	−0.305	0.172	2037 *
SER13	Minimum customization ERP → Pre-implementation phase factors	−0.219	0.216	−0.185	0.143	1533 *
SER14	National culture → Pre-implementation phase factors	−0.211	0.238	−0.196	0.166	1275 *
SER15	Composition of a capable and balanced project team → Pre-implementation phase factors	−0.285	0.142	−0.246	0.133	2148 **
SER16	Controlled ROI on ERP implementation → Pre-implementation phase factors	−0.013	0.444	−0.012	0.167	0.080 ***
SER17	Realistic expectations → Pre-implementation phase factors	0.004	0.303	−0.003	0.165	0.023 **
SER18	Implementation strategy and goals achievement timeframe → Pre-implementation phase factors	−0.056	0.466	−0.040	0.208	0.268 *
SER19	Top management support and commitment → Pre-implementation phase factors	0.317	0.569	0.275	0.143	2215 ***
SER20	Accuracy, Quality and Data Integrity → Implementation phase factors	0.727	0.598	0.585	0.239	3038 ***

Table 8. *Cont.*

S/N	Causal Relationships	Item Weight	Item Loading	Sample Mean	Standard Deviation	T Statistics
SER21	Users' characteristics, skills and capabilities → Implementation phase factors	−0.179	0.337	−0.115	0.214	0.836 **
SER22	Communication plan → Implementation phase factors	0.209	0.407	0.165	0.179	1166 **
SER23	Company-Wide Support and Commitment→ Implementation phase factors	−0.172	0.228	−0.159	0.232	0.744
SER24	Existence of empowered decision-makers → Implementation phase factors	−0.389	0.197	−0.362	0.204	1913 *
SER25	Organizational culture → Implementation phase factors	0.434	0.533	0.354	0.198	2.188 ***
SER26	Users and stakeholders' involvement → Implementation phase factors	0.606	0.555	0.499	0.214	2.833 ***
SER27	Presence of project champion and adequate role → Implementation phase factors	−0.478	0.219	−0.393	0.208	2295 **
SER28	Project management → Implementation phase factors	0.374	0.534	0.325	0.237	1577 ***
SER29	Recognition of qualifications, reward and motivation → Implementation phase factors	0.450	0.375	0.382	0.206	2184 **
SER30	Service Quality → Implementation phase factors	0.069	0.364	0.073	0.215	0.319 **
SER31	System Quality → Implementation phase factors	−0.315	0.363	−0.260	0.234	1347 **
SER32	ERP, business and business processes alignment → Implementation phase factors	0.017	0.370	0.004	0.268	0.063 *
SER33	Software testing, customization and troubleshooting → Implementation phase factors	−0.126	0.380	−0.087	0.244	0.518 *
SER34	Training → Implementation phase factors	−0.214	0.204	−0.169	0.184	1.165
SER35	Monitoring, Evaluation and Feedback → Implementation phase factors	0.842	0.926	0.800	0.205	4106 ***
SER36	Post-implementation audit → Post-implementation phase factors	−0.247	0.518	−0.247	0.299	0.824 *
SER37	System support/Maintenance and further training → Post-implementation phase factors	0.503	0.692	0.485	0.274	1836 ***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

As in the case of examining critical factors as dimensions of the system's implementation, in this particular case, also, all of the factors cannot be examined collectively in this implementation success model. Thus, some factors should be omitted in order for the model's validity to be maximized. Once the factors were removed, the model was revised, the conditions of the measurement model were confirmed and the analysis proceeded to the structural model evaluation, where no collinearity problem emerged (VIF < 3.3) (Table 9).

Table 9. Collinearity assesment in the structural model (Dimensions of ERP life-cycle).

Exogenous Variables	Degree of ERP System Success
Pre-implementation phase factors	1.297
Implementation phase factors	1.300
Post-implementation phase factors	1.335

Then, it turned out that R^2 is equal to 0.280, which is something that points out that the changes in the importance of critical factors explain the 28% of the variability of the ERP success degree. Finally, R^2 turned out to be statistically different from zero, which highlights the model's adaptability (Table 10). If Adjusted R^2 is taken into account, the resulting percentage is 27%, which is slightly lower than that of R^2.

Table 10. R^2 and Adjusted R^2 of the model (Dimensions of ERP life-cycle).

Endogenous Variable	R^2	Sample Mean	Standard Deviation	T Statistics	*p* Values
Degree of ERP system success	0.280	0.360	0.052	5.398	0.000
Endogenous Variable	**Adjusted R^2**	**Sample Mean**	**Standard Deviation**	**T Statistics**	***p* Values**
Degree of ERP system success	0.270	0.352	0.053	5.142	0.000

Consequently, f^2 (effect size) values for each one of the model's causal relationships were extracted (Table 11). The results point out that the degree of ERP system's implementation success is moderately affected by the importance of pre-implementation phase factors (f^2 = 0.180). The effects of implementation phase factors (f^2 = 0.076) and post-implementation phase factors (f^2 = 0.009) are small and zero respectively.

Table 11. f^2 (effect size) for the model's causal relationships (Dimensions of ERP life-cycle).

Causal Relationships	f^2	Sample Mean	Standard Deviation
Pre-implementation phase factors → Degree of ERP system success	0.180	0.239	0.074
Implementation phase factors → Degree of ERP system success	0.076	0.110	0.047
Post-implementation phase factors → Degree of ERP system success	0.009	0.010	0.010

Through the research hypotheses testing, it emerged that, apart from the post-implementation phase factors (T = 0.369, p = 0.712), which the null hypothesis (H_{03}) was accepted for, there are relatioships between the importance that is laid on the respective dimensions and the degree of success. With regard to the kinds of the relationships, all of the dimensions show positive relatioship with the degree of ERP system's implementation success (Table 12).

Table 12. Path Coefficients, *p* and T values for the model's causal relationships (Dimensions of ERP life-cycle).

Causal Relationships	Original Sample	Sample Mean	Standard Deviation	T Statistics	*p* Values
Pre-implementation phase factors → Degree of ERP system success	0.410	0.442	0.054	7.567	0.000 ***
Implementation phase factors → Degree of ERP system success	0.266	0.296	0.058	4.626	0.000 ***
Post-implementation phase factors → Degree of ERP system success	−0.092	−0.070	0.058	1.583	0.113

*** $p < 0.01$.

5. Discussion

In order for the relationships between implementation success and critical factors, as dimensions of the system's implementation, to be identified, PLS-SEM method was used. Taking into account critical factors collectively, it emerged that importance is placed on human, organizational, technological/ERP, project and external partners' factors. This separation arose from the categories that were indicated by [10], who considered them as dimensions of the system's implementation. Essentially, if agricultural processing industries focus is on "human element" or human dimension, then the management and the corresponding indication of emphasis on the factors, which are referred to as human in the model, will be brought about. In case, though, that the industries' focus is on the "organizational element", the management and the corresponding indication of emphasis on the factors, which are referred to as organizational, will be brought about.

Through the analysis, it emerged that 4 out of 5 respective research hypotheses were accepted, since the results showed that the importance that was placed on human, organizational, technological/ERP and external partners' factors is significantly related to the degree of ERP system's implementation success. Also, it was emerged that all of the factors' categories have a positive relationship with the successful implementation, except the external partners' factors, which resulted in a negative one. This fact points out that the greater the emphasis that is placed on the positively correlated dimensions of factors is, the stronger the ERP system success becomes. Negative relationship, however, points out the opposite, as in the case of external partners' factors. Specifically, it could be mentioned that a negative relationship between these parameters maybe arises when external partners are only restricted to the software's installation and its basic maintenance without transferring their knowledge about the system's implementation and providing services, which are related to its optimization, according to the company's needs and the business processes [56–58]. Thus, special attention is proposed to be paid, from the beginning, to the correct choice of vendors and consultants [57], considering specific criteria [59], so as for the use of external partners not to concern only the installation and maintenance of the system. At the same time, an effort should be made in order for an effective cooperation among consultants, vendors and the company itself to be achieved, which is something that will lead to the solution of various problems [24]. The above facts will determine the level of service quality and, consequently, ERP success.

Regarding the project factors, the results showed that their importance is not significantly related to the degree of ERP system's implementation success, which indicates that if industries focus on the elements of this dimension, the ERP success degree will not change. This may be due to the fact that more elements, which, in this particular case, were removed because they did not meet validity characteristics, should be taken into account when the project dimension is examined. A test of the model, which relative indicators were not removed from, showed that a statistically significant relationship between the examined parameters exists. This fact verifies what [60] believe; the remove of indicators is not recommended in the case of a formative model even if they do not meet validity characteristics because the final result may be affected. Based on the above statement, it could be concluded that all factors, which are related to the "project" dimension, must be taken into account in order for the implementation of ERP system to be successful.

A similar analysis was performed on the system's life stages and indicated that 2 out of 3 relative research hypotheses were accepted, as the results showed that the importance that was placed on the pre-implementation and implementation phase factors is significantly related to the degree of ERP success in a positive way. The positive relationship between the above parameters points out that the more importance is placed on these factors' dimension, the stronger the success of the ERP system, and vice versa, becomes. Essentially, if agribusinesses -specialized in the field of agricultural products processing- focus is on "pre-implementation elements" and "implementation elements", then the management and the corresponding emphasis on the factors, which are referred to as pre-implementation and implementation phase factors in the model, will be brought about.

With regard to the post-implementation phase factors, the results were non-statistically significant. Thus, it turns out that if the industries' focus is on the elements of this dimension, the degree of successful implementation will not change. This may be due to the fact that, apart from the factors that have already been defined, such as system support (maintenance, upgrade, additional training) and post-application monitoring, more features should be considered during the last life stage of the system. According to the literature, industries should perform one upgrade to the system every three years, which is considered critical to be done, as well as some regular ones, so as for its smooth operation to be ensured [61]. These upgrades can be carried out only in the case of integrated ERP projects, rendering the provision of personal and financial resources as well as the high level of know-how necessary.

6. Conclusions

Determining the relationships between critical factors and ERP success is of deep interest. Therefore, in the present research, the corresponding analysis in Greek agricultural processing industries, which are located in the region of Central Macedonia, was selected to be implemented. It is believed that such an investigation has never taken place in Greece by now.

In order for this investigation to be carried out, 8 research hypotheses were created by taking into account the critical factors collectively, as aspects of system's implementation (5 research hypotheses) and its life-cycle (3 research hypotheses), and they are tested through the use of Partial Least Squares Structural Equation Modeling (PLS-SEM). Through the answers given in the context of the above statistical analyses, it was determined whether the importance that is shown to two different versions of critical factors is related to the degree of ERP systems' success—or not—and in which way. Based on that, useful guidelines were developed in order for professionals and managers to understand the ways in which critical factors can be taken into account so as for the successful implementation of ERP in agribusinesses -specialized in the field of agricultural products processing- to be feasible.

In case ERP stakeholders take into account the critical factors as dimensions of implementation a positive big interest in the human, organizational, and technology elements is indicated. This fact leads to the conclusion that Central Macedonian agricultural industries give much importance to how the company's structure and general administration must be in order for the system to be supported in terms of costs and resources. Lastly, a positive impact is placed in terms of users' skills and technological background. Therefore, it could be said that in the event that an agricultural processing company wishes to acquire an ERP system in the future or to improve the existing one, it should initially take into account the above characteristics which are elements of human, technological and organizational dimensions. In case that factors are taken into account as dimensions of the ERP system's life cycle, positive importance is indicated in procedures that take place during the pre-implementation and implementation phases. A corresponding suggestion could be to provide useful guidelines to professionals and managers in case they desire an ERP introduction giving much attention to the processes of employees and business adjustment. For these industries that already implement the ERP system, it is suggested that the organization, software testing, and its continuous customization activities be taken seriously in order for the ERP implementation to be successful and profitable.

It should be mentioned that through the present identification these management version/points of view are being provided but also the scientific literature regarding the Greek and Central Macedonian field, is enriched. Lastly, the quotation of the two versions, constitutes an originality in the present study. Stating these two management ways (system's implementation and its life-cycle characteristics), the creation of a multilateral proposal was allowed, giving the managers and professionals the ability to choose the ways in which they want to act in terms of successful ERP implementation achievement, which will bring further business benefits within the business environment. The managers will choose the way in which they want to act, even though the authors suggest that critical factors to be taken into account collectively, as aspects of implementation, since, in this way, emphasis is placed on most of the ERP framework's aspects. After all, as the literature points out, this way gives the ERP implementers the opportunity to be aware of the field where problems regarding the system's implementation may arise [6].

Unfortunately, in the case of this study, there were some inevitable limitations. One of them concern the research sample that could be specifically formed in case the number of Central Macedonian agricultural industries was known. In parallel, the R^2 and f^2 values. The particular values were found low, according to the analysis of the coefficients above, however, not only are they accepted from other relevant studies, but smaller values than them are acceptable, too [62]. So, it is argued that even a small effect size can make sense under extreme measurement conditions [63]. Lastly, the study area's companies were limited in relation to the sum of Greek agricultural processing companies. The solution to this problem may be feasible through a research approach that is proposed to be implemented in other Greek regions as well, in order for answers regarding the ERP systems' implementation specifics and their success to be received.

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