# Application of a Hybrid SEM-MCDA Approach for Examination of Different Industries' Attitude to Use ERP System

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*Abstract: Enterprise Resource Planning (ERP) systems have attracted companies' attention and become an indispensable part of business practice. The success of implementing an ERP system depends on the employees' beliefs, attitudes, and behavior, which affects how employees will accept the new technology. Using the Technological Acceptance Model (TAM), it is possible to examine the ERP system adoption and acceptance factors. Structural equation modelling (SEM) is a useful way to examine the TAM constructs, while multicriteria decision-making analysis (MCDA) helps consider a set of alternatives and criteria. This paper applies the hybrid SEM-MCDA technique to arrive at answers about different industries' attitudes towards ERP system use. To apply this hybrid approach empirical research has been taken based on an online questionnaire. For using this noves approach in the first stage SEM model has been used, and in second stage results of SEM has been upgraded with MCDA technique.*

*Keywords: ERP system, Technological Acceptance Model (TAM), Structural Equation Modelling (SEM), Multicriteria Decision-Making Analysis (MCDA)*

# 1 Introduction

Modern business conditions require the integration of a large amount of data, information feedback, quick response, flexibility, and the integration of business functions. To respond to the mentioned challenges, Enterprise Resource Planning (ERP) systems represent a solution [1].

ERP represents a necessity in the modern way of managing both large small and medium-sized enterprises [2]. Business operations of companies require that business processes and activities of various functions such as finance, sales, production planning, human resources, and other relevant functions be connected. ERP systems play a key role in this integration. ERP should serve as a unified system that enables the circulation of data in different departments and business functions [3].

The leading ERP system that completes the organization's operations by integrating all business functions is SAP. This ERP system has numerous advantages over competitors [4], and as such represents the sphere of interest of many studies [5-7].

Although the company's management is aware of the necessity of implementing an ERP system, employees do not always have to follow such an attitude. The success of the ERP system implementation depends on the degree to which the employees accept the ERP system. The Technological Acceptance Model (TAM) can be used to determine the main factors of ERP system acceptance.

The adoption of ERP systems in companies is often explained through contemporary studies and research that combine the TAM model with the PLS technique [8-10] However, previous literature in the field of ERP systems does not often represent the combination of hybrid methods, indicating a research gap. In order to overcome it, this paper attempt to apply this hybrid approach combining PLS with Multicriteria Decision-Making Analysis (MCDA).

The paper is structured as follows: After the introductory part, there follows a description of the research framework and the hypotheses development. The following parts of the paper refer to the applied methodology, results and discussion, and concluding considerations.

# 2 Research Framework and Proposed Hypotheses

The TAM model was developed in 1989, but over time it has been changed, supplemented, and developed by numerous researchers. This model provides a theoretical framework for analyzing the acceptance of new technologies in companies. In that case, it could serve as a model for accepting the SAP ERP system. Contemporary studies and research seek to explain the adoption of ERP systems in companies using the TAM model. The TAM model can consist of

different external variables and internal constructs, and in the literature, different models try to explain the degree of acceptance of the SAP-ERP system. Therefor, in this paper, after broad literature review, existing TAM model proposed by [9], has been chosen and upgraded with hybrid SEM-MCDA.

In mentioned model, five external factors and several constructs have been recognised.

The compatibility of the ERP system refers to the degree of integration of the new technology, ie. ERP systems in the daily activities and work of employees [11]. It can also be defined as the degree to which the ERP system is perceived as a consistent technology with existing values and past experiences [12]. If the employees perceive the new ERP system as compatible, then this will affect their attitude towards its use. Therefore, hypothesis $H_1$ is defined as: Perceived SAP-ERP Work Compatibility would significantly influence users' Attitude towards usage of the SAP-ERP system.

A positive and statistically significant relationship between the usefulness and attitude towards ERP systems has been consistently confirmed in previous research. (Putri et al., 2020; Grandón et al., 2021; Murillo et al., 2021). "The perception of system usefulness strongly influences end-user satisfaction, thus increasing their willingness to use the ERP system more. In light of this, hypothesis $H_2$ was proposed: Perceived SAP-ERP Usefulness significantly affects users' Attitude towards the usage of the SAP-ERP system.

Previous research has confirmed that ease of use has a positive and statistically significant impact on willingness to use the SAP ERP system [10, 13]. Hence, next hypothesis is defined as: $H_3$ Perceived SAP-ERP Easy of use would significantly influence user's Attitude towards usage of the SAP-ERP system

External variables of the model are those that affect or can affect the basic elements of the TAM model [14]. In this paper, the influence of several external variables was investigated, namely: system complexity, system performance, user instructions, social impact, and business process fit. Therefore, $H_4$ is stated as: External Factors would significantly influence user's Attitude towards usage of the SAP-ERP system.

Four perspectives (criteria) are examined in relation to Attitude towards usage of the SAP-ERP system in the proposed conceptual study model (see Figure 1)..

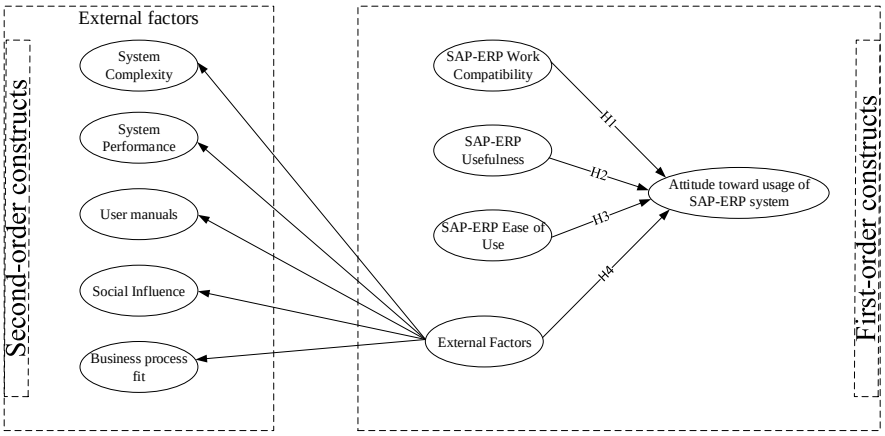


Figure 1

Conceptual Framework

Moreover, four hypotheses with these five main constructs were defined in order to test the positive effect of defined criteria on the Attitude towards usage of the SAP-ERP system

# 3 Methodology

## 3.1 Data Collection

In this study, empirical research was conducted to examine the attitude of ERP system users on the use of the SAP-ERP system. The survey included 150 respondents, 132 of whom responded to the submitted online questionnaire. Respondents represent users of SAP-ERP systems from various industries in Serbia, including the following areas: IT industry, Telecommunications industry, Automotive industry, Industrial Selling, Banking, Pharmaceutical industry, Production, Aviation industry, Mining and metallurgy, and Energy industry.

## 3.2 Stage 1: Structural Equation Modeling

In the stage 1, Structural Equation Modeling (SEM) has been applied. Purpose of using this methodology is to confirm proposed hypotheses ($H_1$ to $H_4$). In this paper PLS-SEM was used because of it's advantages over CB-SEM approach [15]. including complex model with more constructs, variables and relationships, confirmatory approach, absence of need for set normality, and smaller sample size.

As it is shown in Figure 1, SEM model consists of two folds – first order and second order model. In this case, SAP-ERP Work Compatibility, SAP-ERP Usefulness,

SAP-ERP Easy of use are explained as a first-order constructs, and External Factors are established as a second-order constructs.

To carry out this analysis, SmartPLS version 4 was used.

### 3.3 Stage 2: Multicriteria Decision-Making Analysis

In the stage 2, Multicriteria Decision-Making Analysis (MCDA) has been used. The main idea of using this analysis in second stage, is to arrive at relative weightage of each criterion of first-order construct. In order to achieve this, only confirmed hypotheses were used. The relative weightage was calculated following formula:

$$w_j = \frac{\gamma_j}{\sum \gamma_j} \qquad (1)$$

where:

$\gamma_j$ is the result of PLS-SEM estimated path coefficient of the "j"th confirmed hypotheses.

$\sum \gamma_j$ is the sum of estimated path coefficients of all confirmed hypotheses.

## 4 Results and discussion

### 4.1 Stage 1: Structural Equation Modeling

The Structural Equation Modeling (SEM) is used to determine causal relationship between constructs and to determine the weights for further multi-criteria analysis. Two-step procedure was implemented for the data analysis. The first phase focuses on the analysis of the measurement model by using PLS algorithm (Figure 2).

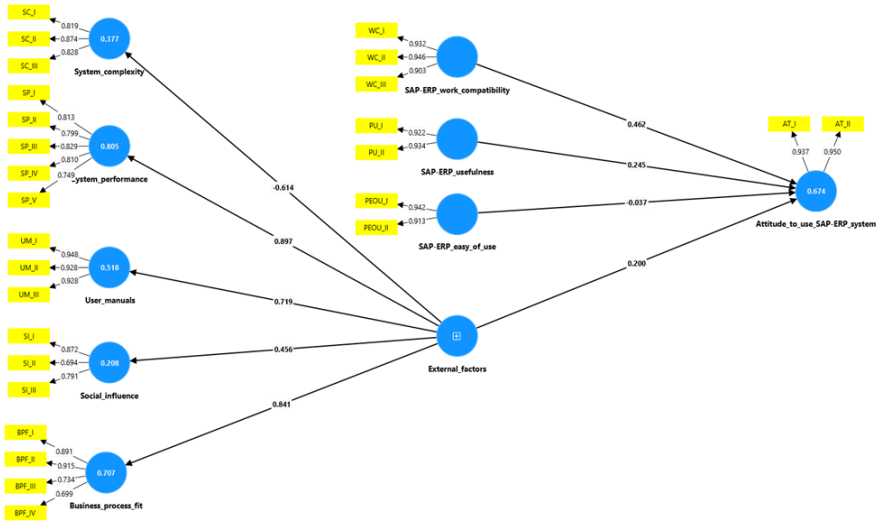


Figure 2

Measurement model

All factor loadings in the measurement model are above 0.70. As a result, the measuring model determined that every item was powerful enough to keep using the structures without eliminating any of them.

A predictor-dimensional exogenous variable External factors had a significant impact on the second-order model's R-square value for the relationship construct with five dimensions: System Complexity (37.7%), System performance (80.5%), User manuals (51.8%), Social influence (20.8%), Business process fit (70.7%). Additionally, each dimension's elements were statistically measured as second-order relationship construct dimensions, moreover, it was confirmed that they can establish the quality reflective model. The coefficient of the path correlation between exogenous latent variable External factors toward the five dimensions showed a strong association between them in descending order: System performance (0.897), Business process fit (0.841), User manuals (0.719), System Complexity (-0.614), Social influence (0.456).

The internal consistency (reliability) statistics were obtained by evaluating Cronbach's alpha and composite reliability (Table 1). The measuring model examined the following indices to verify that they were appropriate: factor loading ≥ 0.50, AVE (Average Variance Extracted) ≥ 0.50, CR (Composite Reilabilty) ≥ 0.70. The results showed that Cronbach's alpha of each construct is more than 0.70, as well, the composite values attained more than 0.70, which confirmed that overall model constructs are reliable for further analysis. The AVE of all constructs achived more than 0.50, except for the exogenous latent variable External factors, which was 0.387.

| | Cronbach's alpha | Composite reliability (rho_a) | Composite reliability (rho_c) | Average variance extracted (AVE) |
|---|---|---|---|---|
| Attitude_to_use | 0.878 | 0.885 | 0.942 | 0.891 |
| Business_process_fit | 0.827 | 0.849 | 0.886 | 0.664 |
| ERP_work_compatibility | 0.918 | 0.919 | 0.948 | 0.860 |
| External_factors | 0.811 | 0.915 | 0.848 | 0.387 |
| Percived_easy_of_use | 0.839 | 0.864 | 0.925 | 0.860 |
| Percived_usefulness | 0.839 | 0.843 | 0.925 | 0.861 |
| Social_influence | 0.704 | 0.754 | 0.831 | 0.622 |
| System_complexity | 0.796 | 0.828 | 0.878 | 0.707 |
| System_performance | 0.860 | 0.861 | 0.899 | 0.641 |
| User_manuals | 0.928 | 0.929 | 0.954 | 0.874 |

Table 1.
Construct reliability and validity

The discriminant validity was tested in order to analyse whether the latent construct differ from other latent constructs. To estimate the degree of shared variance among latent variables in the model, Fornell-Larcker criterion has been used. According to the Fornell-Lacker criterion, in order to eliminate discriminant issues in the SEM model, the square root of each latent variable's AVE should be greater than its association with other latent variables. Results in the Table 2 showed that the square root of each latent variable's AVE are greater than relationship between all other constructs, except for the exogenous latent variable External factors, with the value 0.622.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Attitude_to_use (1) | **0.944** | | | | | | | | | |
| Business_process_fit (2) | 0.684 | **0.815** | | | | | | | | |
| ERP_work_compatibility (3) | 0.789 | 0.751 | **0.927** | | | | | | | |
| External_factors (4) | 0.716 | 0.841 | 0.763 | **0.622** | | | | | | |
| Percived_easy_of_use (5) | 0.409 | 0.403 | 0.461 | 0.587 | **0.928** | | | | | |
| Percived_usefulness (6) | 0.740 | 0.697 | 0.782 | 0.756 | 0.473 | **0.928** | | | | |
| Social_influence (7) | 0.413 | 0.384 | 0.411 | 0.456 | 0.243 | 0.307 | **0.789** | | | |
| System_complexity (8) | -0.490 | -0.388 | -0.510 | -0.614 | -0.593 | -0.557 | -0.136 | **0.841** | | |
| System_performance (9) | 0.596 | 0.668 | 0.626 | 0.897 | 0.521 | 0.673 | 0.270 | -0.511 | **0.801** | |
| User_manuals (10) | 0.396 | 0.465 | 0.434 | 0.719 | 0.387 | 0.420 | 0.245 | -0.275 | 0.554 | **0.935** |

Table 2
Fornell-Larcker criterion

In the second phase, hypothesized structural model was analysed to get outputs of empirical data through PLS path model. The model fit analysis's result showed that only SRMR and Chi-square values are appropriate (Table 3).

| | Estimated model | Acceptable fit |
|---|---|---|
| SRMR | 0.072 | < 0.08 |
| d_ULS | 0.547 | < 0.08 |
| d_G | 0.396 | < 0.1 |
| Chi-square | 318.176 | $p_{val}$>0.05 |
| NFI | 0.774 | >0.9 |

Table 3

Goodness of fit results

After assesing model fit, each hypothesis was tested based on the PLS bootstrapping analysis. The results of hypotheses obtained from of the structural model are shown in the Figure 3.

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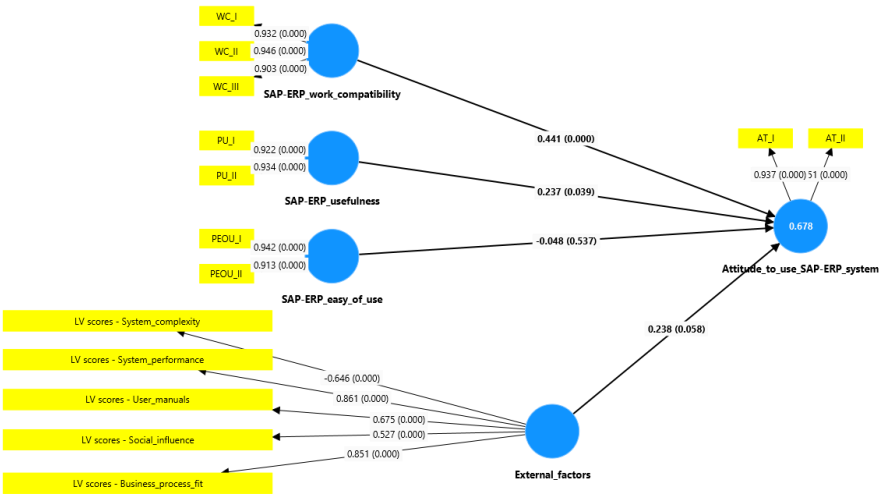


Figure 3

Results of Hypothesized model using PLS bootstrapping algorithm

Additionaly, standardized path coeficients reveal that three of four hypotheses were supported. Resulst are shown in Tabel 4.

| | Construct | Estimated path coefficient | t-statistics | p-value | Remark |
|---|---|---|---|---|---|
| $H_1$ | SAP-ERP Work Compatibility → Attitude toward usage of SAP-ERP system | 0.441 | 4.451 | 0.000 | accepted |
| $H_2$ | SAP-ERP Usefulness → Attitude toward usage of SAP-ERP system | 0.237 | 2.069 | 0.039 | accepted |
| $H_3$ | SAP-ERP Easy of Use → Attitude toward usage of SAP-ERP system | -0.048 | 0.618 | 0.537 | rejected |
| $H_4$ | External Factors → Attitude toward usage of SAP-ERP system | 0.238 | 1.894 | 0.058 | accepted |

Table 4

Results of hypotheses testing

According to results presented in the Table 4, it was determined that SAP-ERP Work Compatibility, SAP-ERP Usefulness and External Factors have a positive and significant effects on Attitude toward usage of SAP-ERP system. Contrary to expectations, it was found that SAP-ERP Easy of Use had a negligible detrimental impact on the dependent variable.

## 4.2 Stage 2: Multicriteria Decision-Making Analysis

The relative weightage is computed only for the criteria according to formula (1). Table 5 presents the normalized standardized path coefficients for these criteria as weights values.

| Criteria | Normalized relative weightage |
|---|---|
| SAP-ERP Work Compatibility | 0.481 |
| SAP-ERP Usefulness | 0.259 |
| External Factors | 0.260 |

Table 5.

Weights of criteria

*From Table 5, it could be seen that SAP-ERP Work Compatibility is the most important criteria (*0.481), following External Factors (0.260) and SAP-ERP Usefulness (0.259).

**Conclusions**

In this paper, a two-stage SEM-MCDA analysis, which represents a hybrid methodology, was applied. Based on the literature review, hypotheses were defined and a research framework was selected. Through empirical research conducted on the territory of Serbia, a research sample of various industries was collected. In the first step, the PLS-SEM methodology was applied to test the set hypotheses. In this

stadium, three hypotheses ($H_1$, $H_2$, and $H_4$) were confirmed, while one hypothesis ($H_3$) was rejected. In the second stage, the relative importance of the confirmed hypotheses was calculated, representing the weight of each criterion. According to the results of this research, among the set criteria, SAP-ERP Work Compatibility is the most important criterion.

Considering the above, it can be said that this paper has several significant contributions. First, it presents the application of a modern hybrid methodological framework in the research area related to ERP systems. Second, it provides an overview of the criteria important for the acceptance of the SAP ERP system, highlighting the quantified importance of each of the criteria.

In addition to the mentioned contributions, this study also has its limitations, such as the number of subjects included, the limitation to the territory of Serbia, and the limitation to SAP as only one of the current EPR systems.

Future research will be aimed at overcoming the mentioned limitations and further development of the methodology, which refers to the application of some of the MCDA tools.

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