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Critical Success Factor for Implementation Enterprise Resource Planning (ERP) in Mining Company PT XYZ from User Perspective

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ABSTRACT

The mining company PT XYZ has been using ERP from 2012 until now. However, the use of ERP is still not optimal: many ERP modules are standalone and not integrated with other modules; existing data in ERP is not actual data yet; and still use other systems that have the same features as ERP. This study aims to evaluate the critical success factor (CSF) for the implementation of PT XYZ's ERP system from the user's perspective and rank the priority of these factors. Analytical hierarchy process (AHP) was used as a method for this study by classifying several criteria and sub-criteria. The results of the classification obtained three criteria, namely organizational factors with the sub criteria of top management support, communication, performance measurement and training education. Environmental factors with sub-criteria for vendor partnership and use of consultants. Technological factors with sub criteria for software testing and information technology infrastructure. Then, pairwise comparisons were made to assess the criteria and sub criteria. Next, determine the priority for each criterion and sub criteria. And finally measure the consistency. The results of this study indicate that organizational factors have top priority that must be considered in order to maximize ERP success. The second priority is technological factors and the third priority is environmental factors that can support the success of ERP.

Keywords: Organizational Factors, Environmental Factors, Technological Factors

INTRODUCTION

In today's rapidly changing global competitive and business environment, staying competitive has become a matter of survival for companies especially in Indonesia. All companies are competing to achieve competitiveness not only in their company's business, but also to compete with the use of information technology to support their company's business. In today's digital era, technology is no longer a secondary strategy but a primary strategy to achieve the company's mission and vision. Enterprise resource planning (ERP) is one of the main tools to achieve competitiveness in business (Reitsma and Hilletofth, 2018). ERP systems provide integration processes in various functional areas with better workflow and standardization, and can access to actual and current data (Umble, Haft, and Umble, 2003). This can be an added value for the company in order to compete with competitors.

ERP is expected to increase efficiency, quality, productivity and profitability through increased capabilities, as well as being able to produce and communicate accurate and timely information. An ERP system can also be used as a company database where all business transactions are entered, recorded, processed, monitored, and reported (Umble *et al.*, 2003). ERP systems are also able to manage more valid and measurable planning which in turn can increase the company's competitiveness and also increase company profits. Apart from its

benefits, not all ERP implementations are successful in ERP development. ERP system implementation is a complex, difficult, expensive and time consuming task (Xue, Liang, Boulton, and Snyder, 2005). Failures that occur when implementing ERP have a negative impact on the company, namely distribution that does not run smoothly, causing losses and also a bad reputation for the company. Lack of user involvement has even been identified as a major factor causing a project to be problematic (Havelka and Rajkumar, 2006).

Therefore, much research has focused on identifying conditions that are believed to increase the likelihood of successful ERP implementation. This condition is usually referred to as a critical success factor (CSF). Understanding CSFs and how they affect ERP implementation outcomes can reduce the risk of failure and provide useful guidance for companies (Huang, Chang, Li, and Lin, 2004). An example of research was conducted on the Retail Industry in India which aims to explore and validate the existing literature empirically to determine the success factors that lead to the successful implementation of ERP (Garg, 2010). Other research was also conducted on industrial geothermal in Kenya which explained that up to 42.3% of CSF factors were successful during ERP implementation (Kemboi, Wanyoike, and Langat, 2019).

Many papers or scientific articles have studied the critical success factors (CSF) that affect the ERP implementation and post-implementation phases in various industries or companies, but very few have examined the mining industry, especially in Indonesia. The mining industry is one of the industries that plays an important role in the wheels of the economy in Indonesia. The mining industry has many business functions that must be integrated to achieve the desired production target. Therefore, many mining industries in Indonesia, one of which is PT XYZ, is trying to use ERP to support integration between these business functions. ERP is expected to help obtain data integration, business process efficiency, and get actual information. But not all ERP implementations have been successfully carried out in the mining industry, especially at PT XYZ. PT XYZ has been using ERP since 2012 until now. However, the use of ERP is still not optimal. There are still many ERP modules that are standalone and not integrated with other modules, the data in ERP is not yet actual data, and still uses other systems with the same features as ERP.

Therefore, the aim of this study is to evaluate the CSF for the implementation of the PT XYZ ERP system from the user's perspective. This research was conducted in two consecutive steps. The first step is to conduct a literature review to obtain a CSF for ERP implementation as a reference. The second step, conducting interviews with ERP system users to determine the critical success factors (CSF) at PT XYZ. The third step, conduct a survey to evaluate the importance of this CSF from a user's point of view. Data were collected by interviewing and distributing questionnaires given to users of the PT XYZ ERP system. Analytical hierarchy process (AHP) is used to rank CSFs in order of importance from the user's point of view, and ultimately facilitate the extraction of the most important CSFs from the user's point of view.

LITERATURE REVIEW

A theoretical study was conducted to obtain a CSF for ERP system implementation. Reitsma and Hilletofth (2018) reviewed 54 scientific articles and summarized 13 CSFs. Of the 13 CSFs, 7 are considered the most important for ERP system implementation by users.

CSF for ERP Implementation

In Reitsma and Hilletofth's (2018) research, four CSFs are considered as “important” for the implementation of ERP systems by users. The first CSF that users see as important is “business process

alignment". The findings of Reitsma and Hilletofth (2018) validate research that discusses CSF from the general perspective of Dezdar and Sulaiman (2009) and Motwani, Subramanian, and Gopalakrishna (2005), which show that users believe organizational implementation needs to select and follow the best business process catalog to remain on the right track and avoid conflicts with the procedural rigor of the ERP system.

The second CSF that users find important is "project support". The findings of Reitsma and Hilletofth (2018) validate research that discusses CSF from the general perspective of Dezdar and Sulaiman (2009) and Wang, Shih, Jiang, and Klein (2008), which show that users believe organizational implementation needs to build project support in the form of technical assistance. , maintenance and renewal, which must be facilitated by a committed partner who oversees the entire implementation life cycle.

The third CSF that users find important is "project management". The findings of Reitsma and Hilletofth (2018) validate research that discusses CSF from the general perspective of Aloini, Dulmin, and Mininno (2007) and Dezdar and Sulaiman (2009), which show that users believe organizational implementation should include a clear definition of goals, job development and resource plans should focus on identifying the equipment required to operate the system.

The fourth CSF that users consider important is "communication". The findings of Reitsma and Hilletofth (2018) validate research that discusses CSF from the general perspective of Aloini *et al.* (2007) and Dezdar and Sulaiman (2009) and Motwani *et al.* (2005), who suggest that users believe organizational implementation needs to establish effective communication at every level of the organization and should include formal project and team promotion and project progress advertisements.

In Reitsma and Hilletofth's (2018) research, two CSFs are considered "not important" for the implementation of ERP systems by users. The first CSF that users consider insignificant for ERP system implementation is "organizational change management". The findings of Reitsma and Hilletofth (2018) contradict studies that discuss CSFs from the general perspective of Aloini *et al.* (2007) and Dezdar and Sulaiman (2009), who show that users believe it is not necessary for organizational applications to utilize change management techniques and tools that must be defined and evaluated with best practices in the industry. This contradicts the research of Deng and Gupta (2005), which argues that most users agree that change management and management of resistance are very important for the implementation of information systems.

The second CSF that users consider insignificant for ERP system implementation is "top management involvement". The findings of Reitsma and Hilletofth (2018) contradict studies that discuss CSFs from the general perspective of Aloini *et al.* (2007) and Dezdar and Sulaiman (2009), who show that users believe the application of top management organizations need not strengthen the commitment of all employees in the organization and make policies that define and approve new organizational structures, roles, and responsibilities.

The CSF framework, Reitsma and Hilletofth (2018) which includes 13 CSFs for ERP system implementation and user perspectives show that there is a degree of difference and consensus between the user perspective of their study and the traditional literature that discusses CSF for ERP system implementation from a general perspective.

Table 1. CSF for ERP Based System Implementation (Reitsma and Hilletofth, 2018)

CSF	Code	User Label	Definition
Project Team	CSF1	Most Important	The project team needs to include the best employees from various functions in the organization and external consultants when ERP system knowledge is lost.
Top Management Involvement	CSF2	Not Important	Top management must strengthen the commitment of all employees in the organization and create policies that define and approve the structure, roles and responsibilities of the new organization.
Strategic Decision Making	CSF3	Most Important	A well-defined business plan and vision should define how the organization operates behind the implementation effort and should outline proposed strategic and tangible benefits, resources, costs, risks and timelines.
Communication	CSF4	Important	Effective communication must be established at every level in the organization and must include formal promotion of the project and its team and progress of the project.
Project Management	CSF5	Important	Project management should include a clear definition of objectives, work development and resource plans should focus on identifying the equipment required to operate the system.
Vendor Support	CSF6	Important	Vendor support should be provided in the form of technical assistance, maintenance, and updates, which must be facilitated by a vendor who is committed to overseeing the entire implementation life cycle.
Minimum Customization	CSF7	Most Important	Departments must not rearrange the selected ERP systems to prevent interdepartmental problems and must have access to the same data and systems.
Organizational Change Management	CSF8	Not Important	Organizations must use change management techniques and tools that must be defined and evaluated against best practices in the industry.
Business Process Alignment	CSF9	Important	The best business process catalog must be selected and followed to stay on the right track and avoid conflicts with the procedural rigor of the ERP system.
Software Testing	CSF10	Most Important	Organizations must create rigorous and sophisticated software testing to simplify ERP system implementation.
Performance Measurement	CSF11	Most Important	Performance measures should be identified to manage expectations, track all events and to measure achievement against milestones and targets.
Education and Training	CSF12	Most Important	Adequate education and training requires investment, promotes the effective and correct use of the ERP system, and should be provided for users from the start of the ERP system implementation project.
Technical Possibilities	CSF13	Most Important	All kinds of differences in ERP systems offered in the market must be evaluated based on strategy, size, business area, business processes themselves, and structure of internal and external relationships.

Analytical Hierarchy Process (AHP)

Analytical hierarchy process (AHP) is a decision-making method with common multicriteria. AHP was developed by prof. Thomas Lorie Saaty from the Wharton Business School in the early 1970s, who used it to assist in solving complex decisions by capturing both subjective and objective evaluation measures. In everyday life, a person is always faced with making choices from various alternatives. Here it is necessary to determine priorities and test consistency of the choices that have been made. In a complex situation, decision making is not influenced by just one factor but is multifactorial and includes various levels and interests (Saaty, 2006).

The main tool of AHP is to have a functional hierarchy with the main input being human perception. With a hierarchy, a complex and unstructured problem is solved into groups and arranged into a hierarchical form. AHP principle is to give weight to each factor, variable, and indicator by comparison between factors, variables, indicators with each other. A greater weight of an indicator indicates a more important indicator than other indicators in determining the economic policy strategy of a region (Saaty, 2006).

AHP uses pairwise comparisons of the importance of criteria with respect to objectives. This pair of comparisons makes it possible to find the relative weight of the criteria with respect to the main objective. If quantitative data is available, comparisons can easily be made based on a set scale or ratio and this causes the inconsistency of the assessment to equal zero which leads to a perfect assessment (Dweiri, Kumar, Khan, and Jain, 2016).

AHP consists of four steps Ansah, Sorooshian, and Mustafa (2015):

1.Create a Hierarchy, where objectives are highlighted and criteria & alternatives are identified. Complex decisions must be broken down into a structural hierarchy from objectives to various criteria and subcriteria to the lowest order. The objectives are represented at the top level of

the hierarchy. Also criteria and subcriteria are represented in the middle of the hierarchy. Finally, the alternatives are assigned at the last level of the hierarchy.

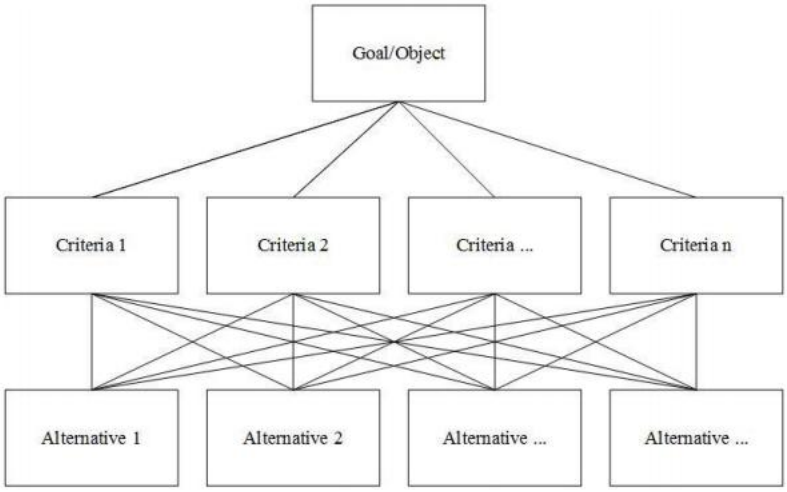

Figure 1. Construction of Structural Hierarchy (Ansah et al., 2015)

2.Assessment of criteria and alternatives, criteria or alternatives is carried out by pairwise comparisons by Saaty (2006), for various problems, a scale of 1 to 9 is the best scale for expressing opinions. The value and definition of qualitative opinion from the Saaty comparison scale can be measured using an analysis table as shown in Table 2 below:

Table 2. Pair Comparison Rating Scale (Saaty, 2006)

Intensity of Interest	Description
1	The two elements are equally important.
3	One element is slightly more important than the other.
5	The elements are more important than the others.
7	One element is clearly more absolutely essential than any other.
9	One element is absolutely more important than any other.
2,4,6,8	The values between two adjacent consideration values.
Inverse	If activity i gets one point compared to activity j, then i has the opposite value compared to i.

3.Synthesis of priority, for each criterion and alternative, pairwise comparisons are required.

4.Logical consistency, consistency has two meanings. First, similar objects can be grouped according to uniformity and relevance. Second, it concerns the level of relationship between objects based on certain criteria.

RESEARCH METHODS

In this study, we need a framework that aims to answer whether the factors that influence the success of ERP implementation at PT XYZ from the user's point of view and what are the most crucial factors and their implications for business processes. Then conduct a literature review that is used as a CSF reference for ERP implementation.

The literature review shows that the authors mainly discuss CSF for ERP implementation from a general perspective. The most recent and relevant papers were selected to form the basis of this study, and in total, 13 CSFs were concluded from this study. Then the authors conducted interviews with ERP system users from representatives of each department/division. The divisions at PT XYZ are IT, accounting/finance, purchasing, inventory, warehouse, plant maintenance, and HR. This interview was conducted to determine what factors influence the success of ERP implementation at PT XYZ from the user's point of view.

Furthermore, these factors are identified and then poured into a decision hierarchy, for decision making analysis and looking for ranking or priority order according to AHP procedures by distributing questionnaires to all users who use the ERP system in all divisions of PT XYZ. The main variable is the variable that is considered the most important to determine the CSF weight value. Sub criteria are variables added by the user in which are fractions of the main variable.

The data that has been collected through a questionnaire will be processed according to the AHP method procedure stages, namely the preparation of pairwise comparison matrices, input values, eigenvector calculations, and preparation of the multiplication matrix between the alternative weight values and the criteria weight values for the calculation of final priority. Followed by an analysis of the results of data processing.

After that the researcher can draw conclusions on the results of the analysis and evaluation that has been done and provide suggestions based on the results of the research that has been done. The mapping of the framework described above can be seen in Figure 2:

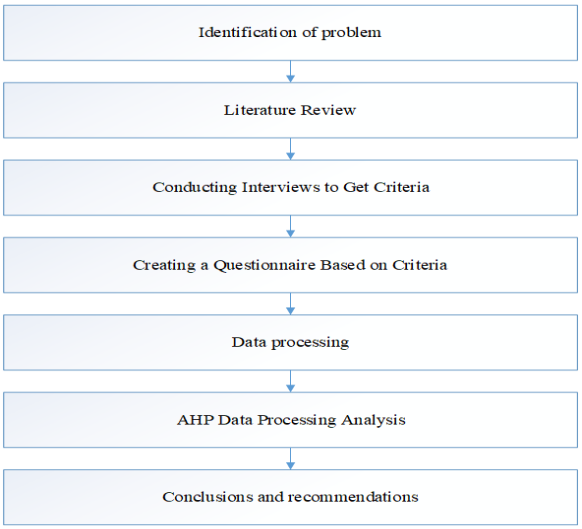

Figure 2. Research Steps

Data Analysis Method

The analytical method used to answer existing problems is using the AHP method, which is to determine the most important/crucial CSF for ERP system implementation. The steps taken are as follows:

Compilation of the Decision Hierarchy

In this stage, a decomposition of the problems at hand is carried out and then compiled into a decision hierarchy. Decomposition is carried out by identifying and decomposing the following components:

1.Purpose

The purpose of the analysis using the AHP method here is to determine and rank CSF.

2.Criteria and sub criteria

The compilation of criteria and sub-criteria was carried out by first conducting a literature study and the results of previous research related to the CSF reference. Then conducted interviews with ERP system users from representatives of each department/division. The divisions at PT XYZ are IT, accounting/finance, purchasing, inventory, warehouse, plant maintenance, and HR. This interview was conducted to determine what factors influence the success of ERP implementation at PT XYZ from the user's point of view. The results of the interviews obtained the criteria and sub-criteria used in this study are shown in Table 3 below:

Table 3. Reference Criteria and Sub Criteria

Criteria	Sub Criteria
Organizational Factors (K1)	Top Management Support (K11)
	Communication (K12)
	Performance Measurement (K13)
	Training and Education (K14)
Environmental Factors (K2)	Vendor Partnership (K21)
	Use of Consultan (K22)
Technological Factors (K3)	Software Testing (K31)
	IT Infrastucture (K32)

At this stage, the AHP model is classified. Pair-wise comparison was also used to rank using sensitivity analysis (Dweiri *et al.*, 2016). The AHP hierarchy is as follows:

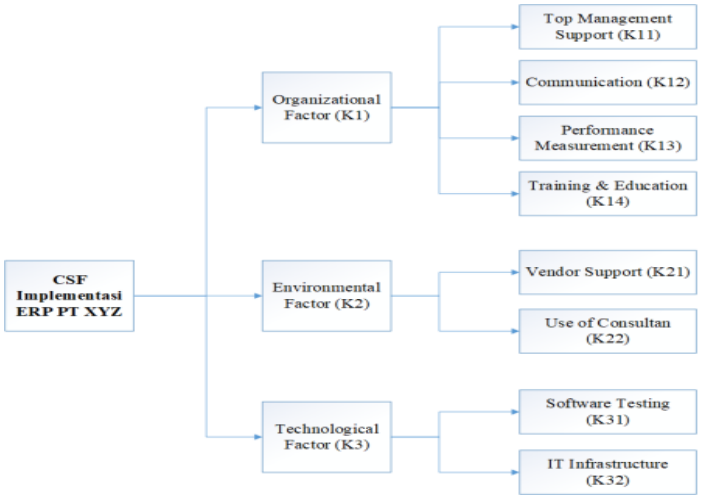

Figure 3. AHP Hierarchy Process

Data Collection

The method used in this study is divided into two parts. The first part conducted interviews with representatives of each division to determine CSF at PT XYZ. The second part of giving questionnaires to users in the form of pairwise comparisons to determine the weight of each criterion. The data needed in this study were obtained in several ways, namely:

1.Literature Study.

2.Interviews with several respondents who are representatives of each division in PT XYZ.

3.Making a questionnaire to determine the level of importance of each level of the hierarchical structure through weighting pairwise comparisons for the same hierarchical level, is done by giving a questionnaire to all ERP system users from all divisions in PT XYZ.

RESULT AND DISCUSSION

This questionnaire was given to 47 respondents which was conducted online using google form. The qualifications of the respondents are presented in Table 4. They were selected based on the criteria for being users of the ERP system. Each questionnaire was validated according to the consistency ratio.

Table 4. Expert Qualifications

Division	Total Respondents
IT	4
HR	4
Accounting	7
Purchasing	8
Plant Maintenance	9
Inventory	7
Warehouse	8

Create a Questionnaire

In the AHP process, the first step taken is compiling a questionnaire to be filled in by respondents which will then be used as a pairwise comparison matrix. The example of the questionnaire is shown in the image below:

	Sangat Dominan	Sangat Kuat	Kuat	Moderat	Sama	Moderat	Kuat	Sangat Kuat	Sangat Dominan	
	9	7	5	3	1	3	5	7	9	
Organizational										Environment
Organizational										Teknologi
Environment										Teknologi

Figure 4. Paired Questionnaires for Each Criteria

	Sangat Dominan	Sangat Kuat	Kuat	Moderat	Sama	Moderat	Kuat	Sangat Kuat	Sangat Dominan	
	9	7	5	3	1	3	5	7	9	
Top Management										Communication
Top Management										Performance Measurement
Top Management										Training
Communication										Performance Measurement
Communication										Training
Performance Measurement										Training

Figure 5. Paired Questionnaire on Organizational Sub Criteria

	Sangat Dominan	Sangat Kuat	Kuat	Moderat	Sama	Moderat	Kuat	Sangat Kuat	Sangat Dominan	
	9	7	5	3	1	3	5	7	9	
Use Consultant										vendor partnership

Figure 6. Paired Questionnaire on Environmental Sub Criteria

	Sangat Dominan	Sangat Kuat	Kuat	Moderat	Sama	Moderat	Kuat	Sangat Kuat	Sangat Dominan	
	9	7	5	3	1	3	5	7	9	
IT infrastrucure										software testing

Figure 7. Paired Questionnaire on Technological Sub Criteria

AHP Data Processing

AHP data calculations are performed using tools as a tool, namely AHP toolsExpert Choice. AHP toolsExpert Choice is already more popular for implementing the AHP method. Expert Choice is very helpful for getting a ranking result or priority order from CSF. The steps for using this tool are the same as the steps in the AHP method, starting from creating a CSF hierarchy then performing pairwise comparisons and computation of consistency. This tool can also display the results in graphical form, making it easier to analyze the priority order of the CSF.

Following are the results of filling out the questionnaire. Figure 8 below is a comparison matrix between criteria after calculating the geometric mean:

	Organizational Factor	Environmental Factor	Technological Factor
Organizational Factor		6,7082	3,0
Environmental Factor			4,58258
Technological Factor	Incon: 0,05		

Figure 8. Comparison Matrix between Criteria after Calculating the Geometry Mean

Because the value of CR = 0.05 is less than 0.1, the matrix can be stated as consistent.

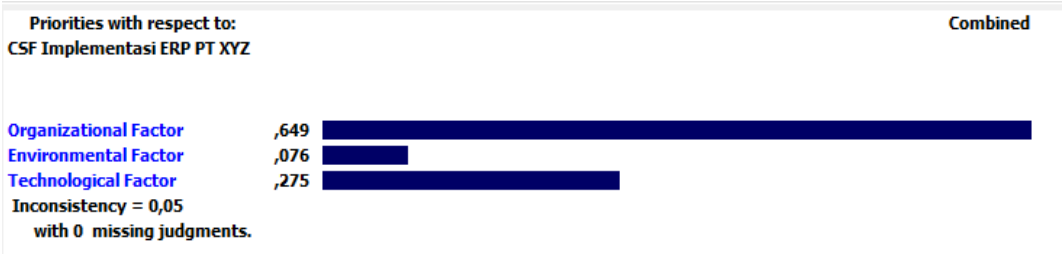

Figure 9. Weighted Criteria Results

From the results of the weighting above, it can be seen that the criteria for organizational factors get the largest weight (0.649) compared to the technological factors (0.275) and finally the environmental factors gets the weight, namely (0.076). Next, Figure 10 below is a

comparison matrix between the organizational factors sub criteria after the calculation of the geometric mean:

	Top Management Support	Communication	Performance Measurement	Training and Education
Top Management Support		1,0	3,0	5,91608
Communication			3,87298	7,0
Performance Measurement				5,0
Training and Education	Incon: 0,05			

Figure 10. Matrix of Comparison between Sub Criteria for Organizational Factors after Calculating the Geometry Mean

Because the value of CR = 0.05 is less than 0.1, the matrix can be stated as consistent.

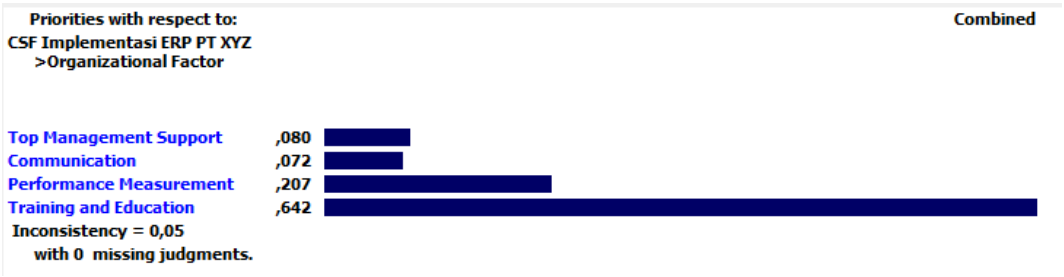

Figure 11. Weighting Results of Organizational Factors Sub Criteria

From the results of the weighting above, it can be seen that for training and education get the largest weight (0.642), performance measurement (0.207), top management support (0.080), and communication (0.072).

next, figure 12 below is a comparison matrix between environmental factors sub criteria after calculating the geometry average:

	Vendor Partners	Use of Consultan
Vendor Partnership		1,68263
Use of Consultan	Incon: 0,00	

Figure 12. Matrix Comparison between Environmental Factors Sub Criteria after Calculation of Geometry Average

Because the value of CR = 0.00 is less than 0.1, the matrix can be stated as consistent.

Figure 13. Weighting Results for Environmental Factors Sub Criteria

From the results of the weighting above, it can be seen that the use of consultant gets the largest weight (0.627) and the vendor partnership (0.373).

Next, Figure 14 below is a comparison matrix between technological factors sub criteria after the calculation of geometric mean:

	Software Testing	IT Infrastucture
Software Testing		6,47356
IT Infrastucture	Incon: 0,00	

Figure 14. Matrix of Comparison Between Sub Criteria for Technological Factors after Calculating the Geometry Mean

Because the value of CR = 0.00 is less than 0.1, the matrix can be stated as consistent.

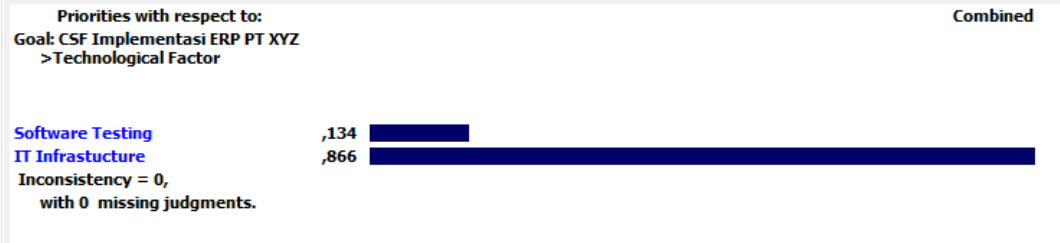

Figure 15. Results of Weighting Sub Criteria for Technological Factors

From the results of the weighting above, it can be seen that IT infrastructure gets the largest weight (0.866) and software testing (0.134).

AHP Data Processing Results Analysis

Analysis of the results of AHP data processing related to CSF ERP implementation at PT XYZ sorted from the most important priorities can be seen in Figure 16 below:

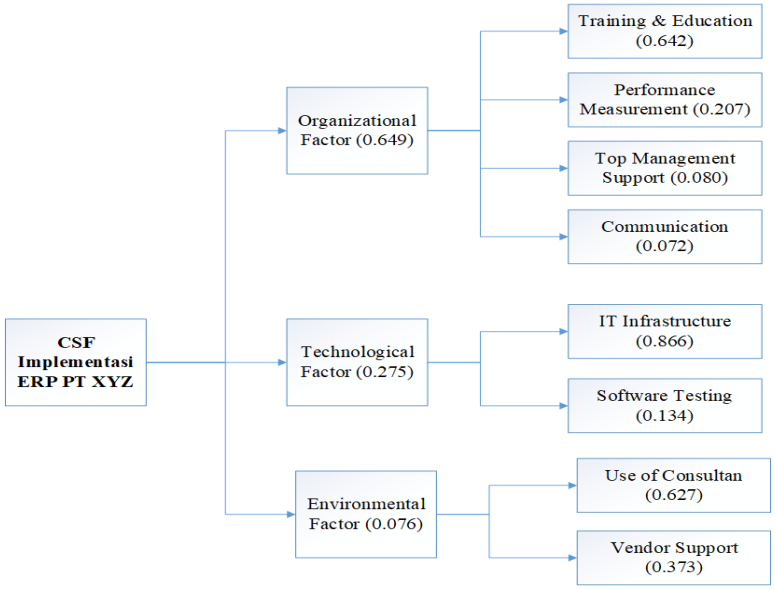

Figure 16. Results of CSF Priority Sequence Analysis

The results of data processing using AHP on each criterion are organizational factors, then technological factors and finally environmental factors.

The results of data processing using AHP on the sub-criteria for organizational factors are training and education as the first priority, second performance measurement, the third is top management and finally communication.

The results of data processing using AHP on the sub-criteria for technology factors, namely IT infrastructure as the first priority, including software testing

The results of data processing using AHP on the environmental factors sub-criteria of use of consultants as the first priority, second donor support.

CONCLUSION AND SUGGESTION

Conclusion

After the analysis and discussion stages are carried out using the analysis stage with the analitycal hierarchy process (AHP), it can be concluded as follows:

1.In the AHP analysis, there are several sub-criteria that must be improved, namely, based on the results of the ranking are as follows: the first ranking is on the organizational side, which means that organizational influence is a top priority that must be increased with a weight of 0.649 or

64.9%. Where in this dimension, Training and Education is the main priority seen from its weight of 0.642, the second is Performance Measurement with a weight of 0.207, the third is Top Management Support with a weight of 0.080, and the fourth is Communication with a weight of 0.072.

2.In terms of technology, the second priority is 0.275 or 27.5%. Where in this dimension, the IT Infrastructure criteria are the top priority seen from its weight of 0.866 and the second is Software Testing with a weight of 0.134.3.

3.The last priority is environmental factors with a weight of 0.076 or 7.6%. Where in this dimension, the Use of Consultant criteria is the top priority seen from the weight of 0.672 and the two Vendor Supports with a weight of 0.373.

Suggestion

From the results of this study, the suggestions that the authors can give are as follows:

1.From The Organizational Side

The provision of training and education must be paid more attention. At least every three months, training or refreshment of knowledge is conducted for ERP system users. Then for the performance measurement of each division, a detailed KPI must be made to measure the performance of each division. In the Top management factor, the leadership must strengthen commitment and make policies in the form of SOPs. Finally, users must be more active in communicating.

2.In Terms of Technology

The IT infrastructure must be renewed again, for example adding bandwidth so that internet speeds are more stable and doing full software testing before Go-live software goes to production.

3.From The Environmental Side

There is a need for additional ERP consultants so that the performance of each division is more effective. It is necessary to choose a vendor that can support the ERP system completely and quickly according to user needs.

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