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Evaluation of Consultant Selection Criteria with Level Based Weight Assessment (LBWA) Method in Intelligent ERP (Enterprise Resource Planning) Perspective

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ABSTRACT

Businesses require computer software to manage their processes systematically and flawlessly. The most important of these software is Enterprise Resource Planning (ERP) software that allows many departments to work together. However, ERP software is difficult to install and manage for businesses. Various factors such as the innovations, expectations, user problems, and costs that ERP projects bring to businesses affect the success of ERP projects. At the same time, these difficulties also carry risks. Businesses need consultants to ensure the success of their projects at this point. The selection of consultants for ERP projects is crucial for project success. This is especially critical for ERP software, which is currently transforming. With the influence of new technologies, ERP software is transforming into a new dimension called intelligent ERP (i- ERP). In this transformation process, the selection of consultants has become more critical and strategic. Currently, consultants are required to possess different skills and experiences besides being familiar with ERP data structures and processes. With ERP software's innovations within itself and in the business, other approaches are needed in consultant selection.

In this study, the criteria that could be considered in the selection problem of ERP consultants were evaluated from the perspective of intelligent enterprise resource planning software. The criteria were determined based on the existing consultant selection literature and expert opinions. The LBWA (Level Based Weight Assessment) method, one of the multi-criteria decision-making (MCDM) methods, was used to determine the criteria weights. LBWA method was preferred in this study because it is more advantageous for decision-makers in decision-making compared to other methods. According to the results obtained with the LBWA method, the most critical criteria in selecting consultants were respectively determined as employee competence, references and support cost. Although there are studies in the literature on consultant selection, this study is considered unique because it focuses on consultant selection from the perspective of i-ERP projects. In this sense, it is expected to contribute to the literature.

Keywords: *Intelligent Enterprise Resource Planning, Intelligent ERP (i-ERP), Consultant Selection, LBWA*

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Akıllı ERP (Kurumsal Kaynak Planlama) Perspektifinde Düzey Temelli Ağırlık Değerlendirmesi (LBWA) Yöntemi ile Danışman Seçim Kriterlerinin Değerlendirilmesi

ÖZET

İşletmeler süreçlerini sistematik, hatasız yönetebilmek için bilgisayar yazılımlarına ihtiyaç duymaktadırlar. Bu yazılımlardan en önemlisi birçok departmanın bir arada çalışmasına olanak sağlayan Kurumsal Kaynak Planlama (ERP) yazılımlarıdır. ERP yazılımları işletmeler açısından kurulumu ve yönetilmesi zor projelerdir. ERP projelerinin işletmeye getirdiği yenilikler, beklentiler, kullanıcı sorunları, maliyet gibi birçok detay ERP projelerinin başarısını etkilemektedir. Aynı zamanda bu zorluklar riskleri de beraberinde getirmektedir. Bu noktada işletmeler projelerinin başarılı olması için danışmanlara ihtiyaç duymaktadır. ERP projelerinde danışman seçimi projenin başarısı için çok önemlidir. Özellikle günümüzde bir dönüşüm süreci yaşayan ERP yazılımları için bu süreç daha kritiktir. ERP yazılımları yeni teknolojilerin etkisiyle a-KKP (Akıllı ERP) ismi verilen yeni bir boyuta dönüşmektedir. Bu dönüşüm sürecinde danışman seçimi daha önemli ve stratejik bir hal almıştır. Artık sadece ERP veri yapısına ve süreçlerine hâkim olması yetmeyen farklı yetenekler ve tecrübeler aranan danışmanlara ihtiyaç duyulmaktadır. ERP yazılımlarının kendi içeriğinde ve işletmede yarattığı yeniliklerle beraber danışman seçiminde de farklı yaklaşımlara ihtiyaç duyulmaktadır.

Bu çalışmada ERP danışman seçimi probleminde dikkate alınabilecek kriterler akıllı kurumsal kaynak planlama yazılımları açısından değerlendirilmiştir. Kriterlerin belirlenmesinde mevcut danışman seçimi literatürü ve uzman görüşünden yararlanılmıştır. Kriterlerin ağırlıklarını belirlemek için ÇKKV (Çok Kriterli Karar Verme) yöntemlerinden birisi olan LBWA (Düzey Temelli Ağırlık Değerlendirmesi) kullanılmıştır. Çalışmada LBWA yöntemi karar vericiler için diğer yöntemlere göre karar vermede daha avantajlı olması nedeniyle tercih edilmiştir. LBWA yöntemiyle elde edilen sonuçlara göre danışman seçiminde en önemli kriterler sırasıyla çalışan yetkinliği, referans ve destek maliyeti olarak belirlenmiştir. Literatürde danışman seçimine yönelik çalışmalar bulunmakta olsa da çalışma a-KKP projeleri perspektifinde danışman seçimine yönelik olması nedeniyle özgündür. Bu anlamda literatüre katkı sunacağı düşünülmektedir.

Anahtar Kelimeler: *Akıllı Kurumsal Kaynak Planlaması, Akıllı ERP (a-KKP), Danışman Seçimi, LBWA*

1. INTRODUCTION

Businesses require various software tools to control their processes. Many departments, from procurement to sales and marketing, and from production to human resources, utilize these software programs to conduct their processes. ERP (Enterprise Resource Planning) software is at the forefront of these software solutions. ERP systems consist of various modules designed to address specific business problems (Andersson, 2022). To manage these modules and ensure effective and efficient software use, businesses require support during the installation and post-implementation phases. Therefore, the consultancy process during the setup and ongoing use of ERP systems is crucial for every company (Maditinos et al., 2011). This support becomes possible through consultancy services.

Vendors and consultants are critical components in ensuring the success of ERP systems (Shimange and Pillay, 2022). Consultants play a variety of roles in ERP applications, such as capturing customer requirements, guiding them towards best practices, and managing projects (Baker and Haddara, 2019). The need of consultants who can guide implementation is critical for businesses (Haddara, 2014). Therefore, selecting consultants for ERP projects is of utmost importance. With technological innovations, especially through applications of artificial intelligence, ERP systems have transformed. This has led to the emergence of intelligent ERP (Morris et al., 2016). Businesses require competent consultants, particularly those with expertise in artificial intelligence applications, to develop intelligent applications or ensure the sustainability of existing applications. The selection of ERP consultants should be approached with more specificity than ever.

In this study, the Level-Based Weight Assessment (LBWA) method, a multi-criteria decision-making (MCDM) method, was used for consultant selection. The proposed LBWA method offers several advantages over traditional MCDM methods, especially in terms of simplifying the decision-making process and increasing the reliability of the results. One of the main benefits of the LBWA method is that decision-makers can express their preferences using minimal comparisons. The expert only needs to make n-1 comparison for the "n" criteria. This method has an advantage over methods like the Analytical Hierarchy Process (AHP) and the Best-Worst Method (BWM), which can lead to potential inconsistencies in the results (Korucuk et al., 2022; Saha & Roy, 2021; Ayan et al., 2023). The LBWA method employs a simple mathematical algorithm that does not become increasingly complex as the number of criteria increases. In contrast, AHP and BWM may add complications that cause decision-makers to become confused and judgement errors (Khan et al., 2021; Atan, 2023).

In addition, a further layer of robustness that enables decision-makers to comprehend how modifications in criterion weights impact overall decision outcomes is the LBWA model's capacity to conduct sensitivity analysis using the elasticity coefficient (Ayan et al., 2023). In summary, the LBWA method stands out among MCDM techniques because it requires fewer comparisons, is a simple algorithm that maintains its simplicity regardless of how many criteria are used, and has the capacity to reduce inconsistencies in expert decisions.

This study evaluates the selection criteria for consultants in ERP projects, focusing on intelligent enterprise resource planning. An approach specifically designed for intelligent ERP applications was used to determine the criteria.

2. LITERATURE

ERP systems provide a single system for monitoring company resources and transactions, making them important tools to manage and track company resources (Kulikov et al., 2020). ERP systems are designed to optimize the distribution of corporate resources and help businesses integrate all their resources more quickly and effectively, leading to improved operational performance and increased competitiveness (Chairunnisa, 2019). They also play a vital role in automating daily processes within a company, contributing to

increased efficiency and productivity (Grandhi, 2021). Additionally, ERP systems are useful in decision-making processes by providing valuable information (Barna et al., 2021). Successful implementation of ERP requires attention to factors beyond technology and software, such as information management and project preparation (Kırmızı, 2021).

As the use of artificial intelligence increases and becomes popular, different ideas regarding ERP software have emerged. Fouad et al. (2012) stated that artificial intelligence can be used in ERP software to address decision-making, predictive analytics, and automating routine tasks (Fouad et al., 2012). However, cloud computing technology has introduced a new application approach for ERP systems. It has facilitated the ERP transition processes of small and medium-sized companies, especially in terms of startup costs. ERP software organized with cloud technology offers relatively low cost, scalability, and accessibility from anywhere with an internet connection (Lv et al., 2018). All these developments (artificial intelligence, cloud technology, etc.) have enabled traditional ERP software to be transformed into intelligent enterprise resource planning (i-ERP) software. Although the concept of i-ERP is relatively new, it was first described by Morris et al. in 2016 (Morris et al., 2016).

The advantages and disadvantages of intelligent ERP are summarized in Table 1 (Jenab et al., 2019; Morris et al., 2016; Salur and Kattar, 2021; Verma et al., 2021).

Table 1. Advantages and Disadvantages of Intelligent ERP Systems

Advantages	Disadvantages
Helping to take the right decisions	Implementation Costs
Increasing Quality	Additional training is required
Speeding Up Operations	Making People Lazy
Increasing Flexibility	Taking time
Reducing Costs	Ethical Hesitations
Improving Processes	
Providing Greater Efficiency	

Consultant selection is a crucial part of enterprise resource planning (ERP) implementation. It is important to manage consultant relationships to reap the benefits of ERP projects (Bawack and Kamdjoug, 2022). The selection of consultants is influenced by factors such as domain knowledge, which can affect user satisfaction with the service quality and ERP performance (Lin and Chen, 2007). An ERP consultant plays a major role in changing management during ERP adoption projects (Lunenburg, 2010). An ERP consultant can also help with planning, implement, and track changes to the ERP system during a project (Westrup and Knight, 2000). Implementing ERP systems in organizations brings challenges and risks. At this point, consultants can provide solutions to these risk factors (Lech, 2016). In general, selecting consultants for ERP projects is a critical decision that may significantly affect the success of the implementation process and the performance of the ERP system. The studies conducted to select ERP consultants are presented in Table 2.

Table 2. Studies on the Selection of Consultants

Authors	Subject	Criteria	Method
Kumar et al. (2003)	Critical management issues in ERP implementation	1. Reputation 2. ERP experience 3. Process engineering experience 4. Sector-specific knowledge 5. Methodology/approach 6. Cost 7. Preferred Partner 8. ERP Vendor Partner	Survey and Structured Questionnaire
Cheung et al.	Selection of architectural consultants	1. Company Profile 2. Consulting fees 3. Project strategy 4. Performance History 5. Desire to complete the task at hand	AHP
Tsai et al. (2007)	Examining user service quality satisfaction in ERP consultant selection and investigated performance improvement of ERP systems.	**1. ERP implementation experience of the consultants** **2. Consultant domain knowledge** **3. ERP implementation approaches and tools of the consultants** 4. Consultant fee 5. Project management skills of the consultants 6. ERP implementation experience of the consultants in similar industry 7. Consultant online support	AHP
Saremi et al. (2009)	Selection of TQM consultants	1. Experience 2. Implementation Cost 3. Knowledge of business 4. Technical Skills 5. Management Skills	TOPSIS
Vayvay et al. (2012)	An ERP consultant selection problem: A case study in Turkey	1. Cost 2. Transportation fee 3. Consultancy Cost 4. Work experience 5. Working with Companies 6. Completed Projects 7. References 8. Education level 9. Department from which the consultant graduated 10. Professional Seminars 11. Communication ability 12. Responsibility Awareness 13. Ability to persuade	Project Resource Planning method (PRP) Analytic Hierarchy Process (AHP) Fuzzy AHP Analytical Network Process (ANP)

Martinović, and Delibašić (2014)	Best Consultant for SAP ERP Project	1. Work experience • Company where the consultant is employed • Projects Completed • References • Customer Recommendation 2. Cost • Consultancy Cost • Transportation Cost 3. Communication ability • Awareness of Responsibility • Ability to Persuade 4. Education level • Occupational Seminars	AHP-IBA
Avikal et al. (2022)	Consultant selection in ERP project	1. Reputation 2. ERP project experience 3. Partner of an ERP supplier 4. Cost 5. ERP implementation experience in similar industry 6. Project methodology/approach 7. Process Engineering experience	Fuzzy AHP and COPRAS-G

The criteria in Table 2 were written according to their order in the research findings.

2.1. LBWA (Level Based Weight Assessment)

LBWA**,** a subjective criterion weighting method, was introduced into the multi-criteria decision-making literature by Zizovic and Pamucar in 2019. The method is different from other criterion weighting techniques that make use of this feature because it is based on the logic of classifying criteria into levels based on importance. (Zizovic and Pamucar, 2019).

The LBWA method allows the calculation of weight coefficients with a small number of criterion comparisons. It is suitable for usage in complex decision models with a larger number of evaluations because its algorithm does not become more complex with an increase in the number of criteria (Pamucar et al., 2020). In addition, the LBWA model allows decision-makers' preferences to be expressed rationally with a small number of comparisons while eliminating the need for experts to use a specific scale for expressing their preferences. This ensures wide flexibility to express expert preferences and eliminates any inconsistencies that may occur (Korucuk et al., 2022). Moreover, the algorithm of the LBWA method does not become more complicated as the number of criteria increases, and the weight coefficients of the criteria can be obtained using simple mathematical calculations (Saha and Roy, 2021).

Although the LBWA method is relatively new, it has been used in many studies (Table 3).

Table 3. Previous Research Using the LBWA Method

Author(s)	Year	Topic
Pamucar et al.	2020	Selecting an airport ground access mode using a novel fuzzy LBWA-WASPAS-H decision-making model
Biswas and Pamucar	2020	Facility location selection for b schools in Indian context: A multi-criteria group decision-based analysis
Deveci et al.	2020	Offshore wind farm siting criteria using a novel interval-valued fuzzy-rough-based Delphi method
Ecer	2020	Selection of factory establishment locations
Bozanic et al.	2020	Selection of military camp sites
Ćurčić et al.	2020	Multicriteria analysis of raspberry and blackberry production residue alternatives
Demir and Arslan	2021	Performance evaluation of insurance companies in Turkey
Uluskan et al.	2022	Selection of suppliers for public institutions operating in the railway sector
Çilek	2022	LBWA for cryptocurrency demand
Ogundoyin and Kamil	2023	Selection of gateways on the Internet of Things
Tesic et al.	2023	Serbia earthquake risk assessment.
Božanić et al.	2023	A decision support tool for oil spill response strategy selection: application of LBWA and Z MABAC methods
Özekenci	2024	Personnel Selection in Foreign Trade: A Study
Tatar and Ayvaz	2024	Assessment of Environmental Performance of Ports Using an Integrated LBWA- MARCOS Decision-Making Approach Based on Picture Fuzzy Sets
Ali et al.	2024	Planning off-grid hybrid energy systems using techno-economic optimization and wins in league theory-based multi-criteria decision-making in the wetland areas of developing countries

The LBWA method has an application process consisting of six steps (Zizovic and Pamucar, 2019; Ayçin, 2023: 446-448).

Step 1: Determining the most important criterion in the criterion set (S)

The most important criterion in the criterion set S={C1, C2,…,Cn} is determined by the decision-maker. Assuming that the most important criterion is determined as C1, other stages will be explained.

Step 2: Dividing Criteria into Levels According to Their Levels of Importance

The decision-maker divides criteria into levels at a decision problem stage using the following structure.

Level 1: C_1, determined as the most important criterion, is either equally important or at most 2 times more important than the criteria at this level (except for exactly 2 times).

Level 2: C_1, determined as the most important criterion, is at least 2 times and at most 3 times more important than the criteria at this level (except for exactly 3 times).

Level k: C_1, determined as the most important criterion, is at least k times and at most k + 1 times more important than the criteria at this level (except for exactly k+1 times).

The importance of criterion C_j is denoted by $S(C_j)$ ($j\in\{1,2,\ldots,n\}$) and for each level $i\in\{1,2,\ldots,k\}$ $S=S_1 \cup S_2 \cup \ldots \cup S_k$ is written; it is calculated with the help of equation (1).

$$S_i = \{C_{i1}, C_{i2}, \ldots, C_{is}\} = \{C_j \in S: i \le s(C_j) < i+1\} \quad (1)$$

In addition, for every value of $p,q\in\{1,2,\ldots,k\}$, $p\neq q$ ensures " $S_p \cap S_q = \emptyset$" " Thus, criterion set S is defined.

Step 3: Importance Comparison of Criteria

In this step, the decision-maker compares the criteria whose levels are determined according to their degree of importance. Numbers are assigned to the criteria; thus, each level is evaluated independently. These values are shown as $I_{ip} \in \{0,1,2,\ldots,r\}$. For the most important criterion, $I_1 = 0$. If the C_{ip} criterion is considered more important than the K_{iq} criterion, $I_p < I_q$; If it is of equal importance, $I_p = I_q$. The maximum number assignment for the comparison of the criteria is given by the following:

$$r = maks\{|S_1|, |S_2|, \ldots, |S_k|\} \quad (2)$$

Step 4: Determining the Elasticity Coefficient

Using the r value from the previous step, the elasticity coefficient, which is denoted by r_0 ($r_0 \in r$) at this stage, is determined as $r_0 > r$

Step 5: Calculation of Criteria Impact Functions

The impact function of each criterion is calculated as shown in Equation (3).

$$f(C_{ip}) = \frac{r_0}{i \cdot r_0 + I_{ip}} \tag{3}$$

In Equation 5, i indicates the number of levels, r_0 indicates the flexibility coefficient, and I_{ip} indicates the number assigned to the criterion.

Step 6: Calculation of The Importance Weights of The Criteria

In the last step of the method, to calculate the importance weights of the criteria, the weight of the most important criterion is first calculated using Equation (4).

$$w_1 = \frac{1}{1 + f(C_2) + \cdots + f(C_n)} \tag{4}$$

Then, the importance weights of the other criteria are calculated using Equation (5).

$$w_j = f(C_j) \cdot w_1 \tag{5}$$

$j = 2,3, \ldots, n$; n will indicate the total number of criteria in Equation 5.

3. APPLICATION

The first step in selecting intelligent enterprise resource planning consultants is to determine the criteria. For this reason, three experts with at least 20 years of experience and a literature review were used to create a criterion pool. Information about the experts is presented in Table 4.

Table 4: List of experts determining the criteria

No	Position	Experience (Year)	Gender	Education
E1	ERP Consultant	27 Years	Male	Computer Programing (Associate Degree)
E2	IT Manager	25 Years	Male	Computer Engineering (Bachelor's Degree) Management Information Systems (Master's Degree)
E3	ERP Software Developer	22 Years	Male	Computer Engineering (Bachelor's Degree)

9 criteria were determined from this pool. 7 Criteria were from previous studies, and 2 criteria were newly added. The criteria are listed in Table 5.

Table 5: List of criteria

Criteria		Source
C1	Cost of Adaptation and Application Development	Kumar et al. (2003) Tsai et al. (2007) Saremi et al. (2009) Vayvay et al. (2012) Martinović, and Delibašić (2014) Avikal et al, 2022
C2	Support Cost	Kumar et al. (2003) Tsai et al. (2007) Cheung et al. Vayvay et al. (2012) Martinović, and Delibašić (2014) Avikal et al, 2022
C3	Working Time in This Context (Experience)	Kumar et al. (2003) Tsai et al. (2007) Saremi et al. (2009) Vayvay et al. (2012) Martinović, and Delibašić (2014) Avikal et al, 2022
C4	Employee Quantity (ERP supplier's partner)	Avikal et al, 2022
C5	Employee Competency	Saremi et al. (2009) Vayvay et al. (2012)
C6	Reference	Kumar et al. (2003) Vayvay et al. (2012) Martinović, and Delibašić (2014)
C7	First Impression, Presentation, Ability to persuade	Vayvay et al. (2012) Martinović, and Delibašić (2014)
C8	Support Management System	Tsai et al. (2007)

		Martinović, and Delibašić (2014)
		Vayvay et al. (2012)
C9	Location (Distance of the Consultant to the Company)	Martinović, and Delibašić (2014)

Brief explanations of the criteria are summarized below:

Adaptation and Application Development Costs (C1)

Consultants are often involved in the adaptation or application development stages of ERP processes. Adaptation procedures are performed for different adaptation requirements after the initial installation. Sometimes, this process can develop new intelligent applications connected to ERP. Consultants may participate as needed in these situations to become proficient in the ERP structure. This criterion characterizes the cost of the process.

Support Cost (C2)

Consultants provide support and application development. Support is important for correct application use and response to errors. The cost of consultants' services is also significant for businesses.

Working Time on Intelligent ERP-Experience (C3)

The prior experience of the consultant in ERP is crucial. ERP software is complex in terms of usage because it is developed with a common structure for various industries and needs. Consultants continually improve their skills for each new project, and the experience becomes even more prominent, especially in the context of intelligent applications. Experience is particularly highlighted in the realm of smart applications, where the algorithms, methods, and outcomes significantly contribute to the consultant’s continuous development in this field.

Employee Quantity (C4)

The quantity of consultants' staff is crucial for prompt assistance. This number also includes partner companies. In addition, the number of employees is important for replacing personnel in cases such as termination of personnel. This criterion focuses on the number of employees in terms of i-ERP rather than the total number of employees.

Employee Competency (C5)

The competence of a consultant firm’s employees is much more important than the number of personnel. In particular, employees with i-ERP must be competent. Employee competencies include diplomas, certifications, and experience. This information can be obtained from the company’s website or social media accounts.

Reference (C6)

The company's previous work is also an important criterion when selecting a consultant. Since the study will be conducted from an i-ERP perspective, the choice of consultant is also influenced by the company's prior projects.

First Impression, Presentation (C7)

The first meetings with the candidate consultants may also affect the selection process. Numerous factors influence the company's preference, including presentation, project approach, and business.

Support Management System (C8)

Consultancy companies offer various support management systems to serve their customers. While some companies provide support management via telephone or e-mail, others use special software. There may even be ticket systems.

Location (Distance of the Consultant to the Company) (C9)

The distance between the consultant firm and the company that will receive support may also be a reason for preference. Even though systems can now be managed fully online, businesses may still favor local businesses.

After the criteria were determined, the application steps of the LBWA method were sequentially applied by obtaining opinions from 12 experts who could evaluate the selection criteria for intelligent enterprise resource planning consultants (Table 6).

Table 6: List of experts.

No	Position	Experience (Year)	Gender	Education
E1	ERP Consultant	27 Years	Male	Computer Programing (Associate Degree)
E2	IT Manager	25 Years	Male	Computer Engineering (Bachelor's Degree) Management Information Systems (Master's Degree)
E3	ERP Software Developer	22 Years	Male	Computer Engineering (Bachelor's Degree)
E4	IT Employee	5 Years	Female	Management Information Systems (Bachelor's Degree)
E5	IT Employee	12 Years	Male	Statistics (Bachelor's Degree)
E6	IT Employee	18 Years	Male	Management Information Systems (Bachelor's Degree)
E7	ERP Consultant	20 Years	Male	Business Administration (Bachelor's Degree)

E8	ERP Consultant	16 Years	Male	Computer Engineering (Bachelor's Degree)
E9	Software Developer	7 Years	Male	Computer Engineering (Bachelor's Degree)
E10	Project Manager	18 Years	Male	Business Administration (Bachelor's Degree) Management Information Systems (Master's Degree)
E11	Software Developer	9 Years	Male	Software Engineering (Bachelor's Degree)
E12	ERP Consultant	11 Years	Female	Industrial Engineer (Bachelor's Degree)

Regarding this, the experts first categorized the criteria into levels based on their relative importance before calculating the criteria's importance comparisons, as indicated in Table 7.

Table 7. Expert Evaluations and Importance Comparisons

Importance Levels of Criteria	**Assigned Values (I_p)**
Expert-1	
Level 1 C5, C3, C8, C2, C1	I5=0, I3=1, I8=1,5, I2=2, I1=3
Level 2 C9, C7, C6, C4	I9=0, I7=1, I6=2, I4=3
Expert -2	
Level 1 C2, C5, C8, C4	C2=0, C5=0, C8=1, C4=2
Level 2 C9, C3, C6, C1	C9=0, C3=1,5, C6=2, C1=2,5
Level 3 C7	C7=1
Expert -3	
Level 1 C7, C6, C8, C3, C5, C9, C4, C1, C2	C7=0, C6=1, C8=1,5, C3=2, C5=3, C9=3,5, C4=4, C1=5, C2=5
Expert -4	
Level 1 C5, C8, C4, C2	C5=0, C8=1,5, C4=2, C2=3
Level 2 C1	C1=0
Level 3 C3, C6	C3=1, C6=1
Level 4	

C7, C9	C7=1, C9=1
Expert -5	
Level 1 C5, C4, C2, C1	C5=0, C4=1, C2=2, C1=2,5
Level 2 C3, C8	C3=1, C8=2
Level 3 C6, C9	C6=1, C9=2
Level 4	
C7	C7=1
Expert -6	
Level 1 C6, C5, C2, C1	C6=0, C5=1, C2=2, C1=3
Level 2 C3, C7	C3=1, C7=2
Level 3 C8, C9, C4	C8=1, C9=2, C4=3
Expert -7	
Level 1 C6, C3, C5, C4	C6=0, C3=1, C5=1,5, C4=2
Level 2 C8	C8=1
Level 3 C1, C2	C1=1, C2=2
Level 4	
C7, C9	C7=1, C9=2
Expert -8	
Level 1 C5, C1, C2	C5=0, C1=1, C2=2
Level 2 C6, C7, C8	C6=1, C7=2, C8=3
Level 3 C4, C3	C4=1, C3=2
Level 4	
C9	C9=1
Expert -9	
Level 1 C6, C7, C5	C6=0, C7=1, C5=1
Level 2 C1, C3, C4	C1=1, C3=2, C4=2
Level 3 C2, C8	C2=1, C8=1
Level 4	
C9	C9=1
Expert -10	

Level 1 C5, C2, C1	C5=0, C2=1, C1=2
Level 2 C6, C7	C6=1, C7=2
Level 3 C8, C3, C4	C8=1, C3=2, C4=3
Level 4	
C9	C9=1
Expert -11	
Level 1 C6, C8, C5, C2	C6=0, C8=1,5, C5=2, C2=3
Level 2 C1, C3, C7	C1=1, C3=1,5, C7=2
Level 3 C9	C9=1
Level 4	
C4	C4=1
Expert -12	
Level 1 C6, C7, C5	C6=0, C7=1, C5=2
Level 2 C1, C8, C2	C1=1, C8=1, C2=1
Level 3 C3, C4	C3=1, C4=2
Level 4	
C9	C9=1

After the importance comparisons of the criteria, the elasticity coefficients were determined as $> r$ as shown in Equation (2), and the solution was continued. An example calculation for Expert 1, who evaluated the criteria$_0$ at 2 levels of importance, is given below ($r_0 = 6 > r$). Here, the impact functions were calculated using Equation (3) as follows:

Impact functions for first level criteria:

$$f(C_5) = \frac{6}{\mathbf{1} \cdot 6 + 0} = 1$$

$$f(C_3) = \frac{6}{\mathbf{1} \cdot 6 + 1} = 0{,}857$$

$$f(C_8) = \frac{6}{\mathbf{1} \cdot 6 + 1{,}5} = 0{,}80$$

$$f(C_2) = \frac{6}{\mathbf{1} \cdot 6 + 2} = 0{,}75$$

$$f(C_1) = \frac{6}{\mathbf{1} \cdot 6 + 3} = 0{,}667$$

Impact functions for second level criteria:

$$f(C_9) = \frac{6}{\mathbf{2} \cdot 6 + 0} = 0{,}50$$

$$f(C_7) = \frac{6}{\mathbf{2} \cdot 6 + 1} = 0{,}462$$

$$f(C_6) = \frac{6}{\mathbf{2} \cdot 6 + 2} = 0{,}429$$

$$f(C_4) = \frac{6}{\mathbf{2} \cdot 6 + 3} = 0{,}40$$

After calculating the impact functions, the importance weight of the C5 criterion, which was determined as the most important by Expert 1, was calculated using Equation (4).

$$w_5 = \frac{1}{1 + 0{,}857 + 0{,}80 + \cdots + 0{,}40} = 0{,}1705$$

Finally, with the help of Equation (5), the importance weights of the other criteria were calculated as follows:

$$w_1 = f(C_1) \cdot w_5 = 0{,}667 \cdot 0{,}1705 = 0{,}1137$$

$$w_2 = f(C_2) \cdot w_5 = 0{,}75 \cdot 0{,}1705 = 0{,}1279$$

$$w_3 = f(C_3) \cdot w_5 = 0{,}857 \cdot 0{,}1705 = 0{,}1462$$

$$w_4 = f(C_4) \cdot w_5 = 0{,}4 \cdot 0{,}1705 = 0{,}0682$$

$$w_6 = f(C_6) \cdot w_5 = 0{,}429 \cdot 0{,}219 = 0{,}0731$$

$$w_7 = f(C_7) \cdot w_5 = 0{,}462 \cdot 0{,}219 = 0{,}0787$$

$$w_8 = f(C_8) \cdot w_5 = 0{,}80 \cdot 0{,}219 = 0{,}1364$$

$$w_9 = f(C_9) \cdot w_5 = 0{,}50 \cdot 0{,}219 = 0{,}0853$$

In the next step, a sensitivity analysis was conducted to determine the effect of the elasticity coefficient value. For this purpose, r_0 was modified between 7 and 15. The weight coefficients were calculated as shown in Table 8 and Figure 1.

Table 8. Impact Function Values and Criteria Weights

	$\mathbf{r_0 = 6}$	$\mathbf{r_0 = 7}$	$\mathbf{r_0 = 8}$	$\mathbf{r_0 = 9}$	$\mathbf{r_0 = 10}$	$\mathbf{r_0 = 11}$	$\mathbf{r_0 = 12}$	$\mathbf{r_0 = 13}$	$\mathbf{r_0 = 14}$	$\mathbf{r_0 = 15}$
C1	0,1137	0,1168	0,1193	0,1214	0,1231	0,1246	0,1259	0,1270	0,1280	0,1288
C2	0,1279	0,1298	0,1313	0,1324	0,1334	0,1342	0,1349	0,1355	0,1360	0,1364

C3	0,1462	0,1460	0,1459	0,1457	0,1455	0,1454	0,1452	0,1451	0,1450	0,1449
C4	0,0682	0,0687	0,0691	0,0694	0,0696	0,0698	0,0699	0,0701	0,0702	0,0703
C5	0,1705	0,1669	0,1641	0,1619	0,1601	0,1586	0,1574	0,1563	0,1554	0,1546
C6	0,0731	0,0730	0,0729	0,0728	0,0728	0,0727	0,0726	0,0726	0,0725	0,0725
C7	0,0787	0,0779	0,0772	0,0767	0,0762	0,0759	0,0755	0,0753	0,0750	0,0748
C8	0,1364	0,1374	0,1382	0,1388	0,1392	0,1396	0,1399	0,1401	0,1403	0,1405
C9	0,0853	0,0834	0,0820	0,0809	0,0800	0,0793	0,0787	0,0781	0,0777	0,0773

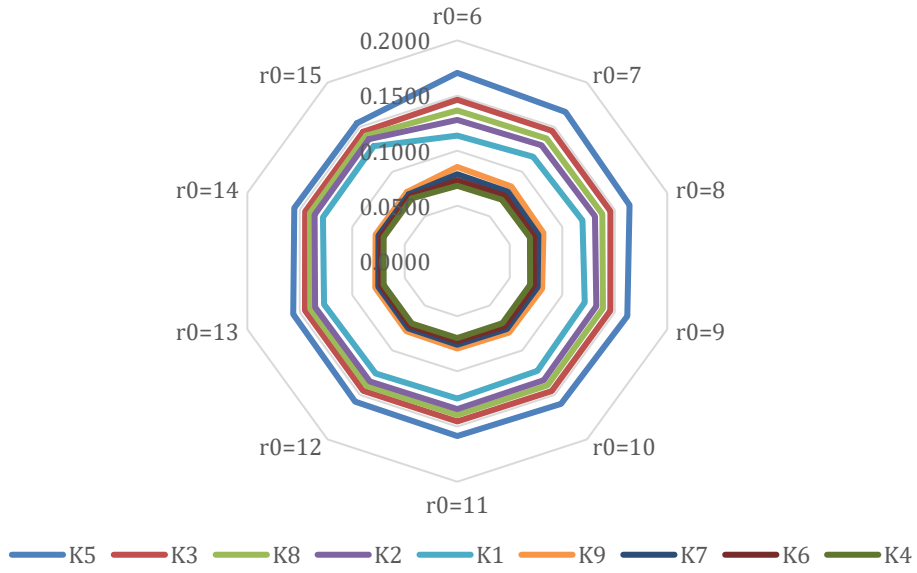

Figure 1. Elasticity coefficients with different r_0 values

As shown in Figure 1, modifying the elasticity coefficient did not change the ranking of the Expert 1 criterion weights. Similarly, all expert views were tested with r_0 values between 7 and 15, and there were no differences in weight coefficient ranking. Sensitivity analysis shows the robustness of the LBWA model for each expert.

Finally, impact function values and criterion weights were calculated according to the evaluations of all experts. This information is summarized in Table 9.

Table 9. Impact Function Values and Criteria Weights

Criteria	Expert 1		Expert 2		Expert 3		Expert 4	
	IF Value	Criterion Weights	IF Value	Criterion Weights	IF Value	Criterion Weights	IF Value	Criterion Weights
C1	0,667	0,1137	0,400	0,0713	0,667	0,0930	0,500	0,1062
C2	0,750	0,1279	1,000	0,1782	0,667	0,0930	0,625	0,1327
C3	0,857	0,1462	0,435	0,0775	0,833	0,1162	0,313	0,0664
C4	0,400	0,0682	0,714	0,1273	0,714	0,0996	0,714	0,1517
C5	1,000	0,1705	1,000	0,1782	0,769	0,1073	1,000	0,2123
C6	0,429	0,0731	0,417	0,0743	0,909	0,1268	0,313	0,0664
C7	0,462	0,0787	0,313	0,0557	1,000	0,1395	0,238	0,0506
C8	0,800	0,1364	0,833	0,1485	0,870	0,1213	0,769	0,1633
C9	0,500	0,0853	0,500	0,0891	0,741	0,1033	0,238	0,0506
Criteria	Expert 5		Expert 6		Expert 7		Expert 8	
	IF Value	Criterion Weights	IF Value	Criterion Weights	IF Value	Criterion Weights	IF Value	Criterion Weights
C1	0,667	0,1352	0,625	0,1268	0,313	0,0647	0,800	0,1776
C2	0,714	0,1449	0,714	0,1449	0,294	0,0608	0,667	0,1480
C3	0,455	0,0922	0,455	0,0922	0,833	0,1724	0,286	0,0634
C4	0,833	0,1690	0,278	0,0564	0,714	0,1478	0,308	0,0683
C5	1,000	0,2028	0,833	0,1691	0,769	0,1591	1,000	0,2221
C6	0,313	0,0634	1,000	0,2029	1,000	0,2069	0,444	0,0987
C7	0,238	0,0483	0,417	0,0845	0,238	0,0493	0,400	0,0888

C8	0,417	0,0845	0,313	0,0634	0,455	0,0940	0,364	0,0807
C9	0,294	0,0597	0,294	0,0597	0,217	0,0450	0,235	0,0522
Criteria	**Expert 9**		**Expert 10**		**Expert 11**		**Expert 12**	
	IF Value	**Criterion Weights**	**IF Value**	**Criterion Weights**	**IF Value**	**Criterion Weights**	**IF Value**	**Criterion Weights**
C1	0,444	0,0947	0,667	0,1513	0,455	0,0915	0,444	0,0960
C2	0,308	0,0655	0,800	0,1816	0,625	0,1259	0,444	0,0960
C3	0,400	0,0852	0,286	0,0648	0,435	0,0876	0,308	0,0665
C4	0,400	0,0852	0,267	0,0605	0,238	0,0480	0,286	0,0617
C5	0,800	0,1704	1,000	0,2269	0,714	0,1439	0,667	0,1440
C6	1,000	0,2130	0,444	0,1009	1,000	0,2014	1,000	0,2160
C7	0,800	0,1704	0,400	0,0908	0,417	0,0839	0,800	0,1728
C8	0,308	0,0655	0,308	0,0698	0,769	0,1549	0,444	0,0960
C9	0,235	0,0501	0,235	0,0534	0,313	0,0629	0,235	0,0508

Finally, in order to conduct a general evaluation, the geometric mean of the criterion weights calculated for the 12 experts were taken. The geometric mean column was normalized so that the total weights were 100%, and the final importance weights of the criteria were calculated as shown in Table 10.

Table 10: Final Criterion Weights

Criteria	Geometric Mean	Final Weights	Order of importance
C1	0,1059	0,1124	4
C2	0,1185	0,1258	3
C3	0,0894	0,0950	6

C4	0,0872	0,0926	7
C5	0,1720	0,1827	1
C6	0,1223	0,1299	2
C7	0,0840	0,0892	8
C8	0,1009	0,1071	5
C9	0,0613	0,0652	9

According to the application results in which intelligent enterprise resource planning consultant selection criteria were evaluated (Table 10), the most important criterion was C5 employee competency (18.27%). This criterion was followed by the C6 Reference (12.99%) and C2 Support Cost (12.58%) criteria, respectively.

4. CONCLUSION

For businesses to manage processes precisely, openly, and without errors, enterprise resource planning (ERP) software is essential. ERP software is either developed or purchased by businesses, depending on their plans, business capabilities, and size. Two important business choices are choosing ERP and a company or individual to offer ERP consulting. Numerous factors influence these decisions. The initial setup or transition processes for ERP are challenging. The selection of an ERP consultant is a significant factor in ensuring the correct implementation of these processes. ERP projects that do not properly evaluate suitable selection criteria often fail. ERP systems have changed due to technological advancements, especially the influence of artificial intelligence. This has resulted in a transformation of the concept of intelligent ERP. The selection of business consultants has taken on a new dimension due to this transformation. Intelligent ERP processes differ from traditional ERP.

From an intelligent ERP perspective, this study assesses the selection of consultants for ERP projects. An analysis is presented on how businesses approach consultant selection and how they evaluate the criteria within the scope of this new concept. In this study, the criteria for the analysis were first determined using past studies and expert opinion. Then, 12 experts who develop and manage Intelligent ERP processes were asked to evaluate the criteria. The LBWA method, which is an MCDM method, was used for the analysis. The most important criterion for selecting ERP consultants from the intelligent ERP perspective was determined as "Employee Competency". Examining earlier research from this angle reveals that "experience" is typically the most crucial criterion in most studies. (Tsai et al. (2007), Saremi et al. (2009), Martinović and Delibašić (2014)). In some studies, the most important criteria are "Reputation" (Kumar et al. (2003), Avikal et al, (2022)) and "Cost"

(Vayvay et al. (2012)). In contrast to earlier research, the study discovered "employee competency" because artificial intelligence applications are frequently incorporated into intelligent ERP procedures. Machine learning, big data analysis, and similar applications require not only software but also ERP knowledge. The expert must also know mathematics and statistics. In this study, the "Reference" and "Support Cost" criteria follow the "Employee competence" criterion in terms of importance. These two criteria are consistent with other studies. Reference is an essential criterion because previous studies on intelligent ERP will affect the choice. "Cost" has also been identified as the most critical criterion in previous studies. The most crucial difference between this and previous studies is the "Experience" criterion. "Experience", which was one of the most important criteria in previous studies, was ranked 6th in this study. The least essential criterion was determined as "Location (Distance of the Consultant's Firm to the Company)". Advances in technology that allow online meetings have made this criterion less critical. The second-least-important criterion is "First Impression, Presentation". Experts emphasized that the first impression is not as important as initially thought.

This study serves as a guide for consulting firms and also businesses involved in "the ERP to i-ERP transformation process". It is believed to contribute to the industry and literature in this regard. Future studies should focus on increasing applications of Intelligent ERP. These projects can be evaluated in terms of critical success factors. The roles and responsibilities of consultants can be reconsidered in these studies.

Statement of Research and Publication Ethics

In all processes of the article, the principles of research and publication ethics of the Manisa Celal Bayar University Journal of Social Sciences Institute were followed.

Authors' Contribution Rates to the Article

The entire article was written by the Author.

Statement of Interest

The author has no conflict of interest with any person or organization.

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