• Determine alternatives, Ai
• Determine the criteria that will be used as a reference in decision-making, Cj
• Provide the compatibility-rating value of each alternative on each criterion
• Determine the level of importance or preference weights (W) for each criterion $W = [W1W2W3 \dots Wj]$. Create a table rating the suitability of each alternative on each criterion.

Making the decision-matrix (X) is formed from the rating table that matches each alternative on each criterion. Value of each alternative $x(Ai)$ on each criteria (Cj) are already determined, where, $i = 1, 2...m$ and $j = 1, 2...n$.

$$X = \begin{bmatrix} x11 & x12 & ... & x1j \\ \vdots & \vdots & \vdots & \vdots \\ xi1 & xi2 & ... & xij \end{bmatrix}$$

Normalized decision-matrix X by calculating the value of the performance value rating (rij) of alternative Ai on criteria Cj.

$$Xij = \begin{cases} \frac{Xij}{max_i(Xij))} \\ \\ \frac{min_i(Xij))}{Xij} \end{cases}$$

Results of normalized performance value rating (rij) matrix normalized form (R).

$$R = \begin{bmatrix} r11 & r12 & ... & ... & ... & r1i \\ : & & & & & : \\ : & & & & & : \\ : & & & & & : \\ ri1 & ri2 & ... & ... & ... & r1i \end{bmatrix}$$

The proposed methodology is intended to make the use of Multiple Criteria Decision Making (MCDM) techniques as efficient as possible [15]. Two different techniques, AHP and SAW, are combined to rank alternative software based on criteria. The reason for employing the well-known AHP technique is to structure the problem's decision hierarchy. Finally, one of the most efficient MCDM techniques, such as SAW, is used to rank the alternatives [25]. The following are the main steps of the proposed integrated methodology to be developed by decision-makers for the database software selection problem:

Step 1: Define criteria and sub-criteria that have the greatest effect on the database software.
Step 2: Construct a hierarchy decision model for the database software.
Step 3: Determine the comparison matrix for each level by using the AHP technique.
Step 4: Determine the global weight by normalizing the local weight.
Step 5: Check the CR
Step 6: Use the SAW technique to assess the alternatives.
Step 7: Select the best Database software alternative.

The illustrates of the proposed integrated methodology to evaluate and select the database as shown in the Figure 1 .

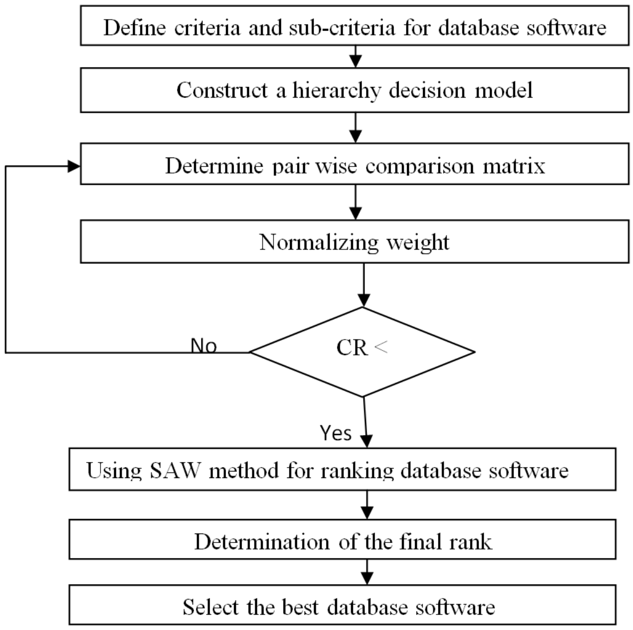

Figure 1: Proposed Integrated Methodology to Evaluate and Select Database Software

3.2 Defining the Attributes and Assigning their Appropriate Metrics

The decision on database software is critical in any business's long-term planning. The contribution proposes an evaluation process for selecting the appropriate OS component, such as database software, in an organization chosen by a group of developers. The evaluation process provides the knowledge required to confirm the choice of a specific method, and without such knowledge, the benefits will be compromised. Thus, selecting the appropriate operating system results in a high degree of reusability and the desired benefits.

Our proposed framework, as described in, [22], is useful for its integrated approach to quality. Each high-level feature of a database software product is accompanied by a set of sub-features. A sub-characteristic is represented further by sets of software quality attributes. As shown in Figure 2, this chain of software quality attributes can be classified into three levels. At the highest level, the so-called 'characteristic' from the perspective of a customer or stakeholder, such as 'Usability.' At the second level, there are the so-called 'Sub-characteristics' or quality factors from the perspective of customers or stakeholders, such as 'Learnability,' 'Operability,' and 'Understandability.' and 'Complexity' [5]. At the third level are the quality criteria (attributes), which represent technical concepts. At the fourth level, the 'Metric' measures the quality criteria (attributes) of the database software product.

The evaluation discussion of the high-level 'Usability' characteristic, as well as their associated

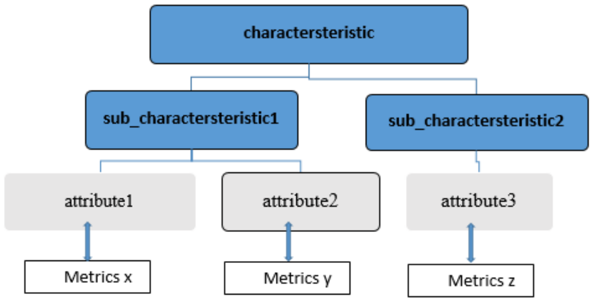

Figure 2: The framework of OS Quality Attributes

sub-characteristics, is provided below. The ability of a software product to be understood, learned, used, and appealing to the user when used under specified conditions is referred to as its usability. The term 'usability' refers to a set of characteristics that influence the effort required for use as well as the individual evaluation of such use by a stated or implied set of users. Furthermore, 'usability' refers to the amount of effort required to learn, operate, prepare input, and interpret output from a program [2]. In an operating system, the majority of component stakeholders are application developers and designers who must create applications with them, and end-users that interact with OS. Thus, a component's usability should be interpreted as to its ability to be used by the application developer and designer when building a new software product. According to [27], the sub-characteristics of 'Usability' are 'Learnability,' 'Operability,' 'Understandability,' and 'Complexity.'

Learnability: The software product can enable the user to learn its application (ISO9126/IEC, 2001). Learnability requires attention to the needs of the beginner and untrained users that have no previous experience with the software or similar software; there are a set of attributes, which aim to measure the time needed to learn the system, like usage, or configuration. Herein, Learnability attributes will be decomposed into the following, according to ISO9126 [3]

There is a set of attributes that try to measure the time needed to master some specific task (such as usage or configuration). Herein, 'Learnability' attributes will be decomposed into the following:
Time to Use: Attribute measures the average time needed for a user to learn how to correctly use the OS component.
Time to Configure: Attribute measures the average time needed to configure the software.
Understandability: the ability of a software product to allow a user to grasp whether the program is appropriate for a certain task and under what conditions it can be used,[3], This property refers to the component's documentation, demos, and tutorials. As a result, we have categorized the properties that help a component's 'Understandability' and hence influence its 'Learnability' under these characteristics. Herein, the 'Understandability' attributes will be decomposed into the following:
Documentation: This category includes end-user documentation. Attribute assesses the completeness, clarity, and usefulness of user documentation. Documentation for computers. Attributes indicate whether the components provide any kind of documentation that component tools can use to understand their services (eg. User Manual, ERM or DFD).
Training: This indicates whether a training course for the software is available.
Support: This evaluates the vendor's level of support through surveys, the web, discussion groups, interviews, and news. 'Operability' refers to a software product's ability to allow the user to operate and control it [22], or the ease with which a program can be operated [3]. The 'Operability' attributes will be decomposed here into the following:
Effort for Operating: indicates the level of effort needed to properly operate the software component.
Administrability: indicates the level of effort needed to properly administer the software component.
Complexity: measuring the complexity of using and integrating the component into the final system. Herein, the 'Complexity' attributes will be decomposed into the
Required Interface: the number of interfaces that the OS component requires from other components to operate. The new framework avoids some of the limitations found in other existing frameworks. The new framework disregards quality characteristics that don't apply to OS components and replaces them with new ones that are. The same new framework has been improved further by identifying new attributes for the framework's quality sub-characteristics and defining metrics rules to measure the quality of these new attributes for the quality sub-characteristics in the framework, and defining metrics rules to measure the quality of these new attributes.

The Figure 2 shows the breakdown of the attributes along with their associated metrics and criteria. In this contribution, the framework is tested using the Integrated AHP-SAW Methodology to evaluate and choose the best operating system database product from Oracle 9i and SQL Server 2005. Database Management System, Internet Application Server 9*i*, Report Builder, Java Database Connection, Application Program Interface, OS Product, Crystal Report, and OS Product.

Web Portal is among the Oracle 9*i* Database Components. SQL Server 2005 Database Components include the following: Database Management System, MS ADO, COM object, OS product VB.NET & VB script, OS product Internet Information Services, OS product MS Index, OS product MS Collaboration Data Object for NT as interface towards an SMTP server, and OS product Crystal Report is shown in Table3 .

Using the Saaty scaling-table, and the AHP six steps, a weight value is assigned for each of the characteris-

Table 3: Characteristics and Sub-characteristics of Usability

Goal (Level-0)	Characteristics (Level-1)	Sub- Characteristics (Level-2)	Attributes (Level-3)
			Effort for Operating.
			Administrability.
		Operability	Documentation.
Choosing			
		Understandability	Training
The Best	Usability		
		Learnability	User Support
(Database Software)			
		Complexity	Time to Use
			Time-to- Configure.
			User interface

tics, namely: 'Learnability', 'Understandability', 'Operability', and 'Complexity'.. The outcome is shown in Table4, Table5, Table6 and Table7 Respectively.

Table 4: Pairwise Comparisons Judgment for the Sub-Characteristics According to Usability (U),Learnability (L),Understandability (UN),Operability (O),Complexity (C)and Priority (p)

U	L	UN	O	C	P
Learnability	1.0	2.0	5.0	5.6	0.52
Understandability	0.50	1.0	2.50	2.80	0.27
Operability	0.20	0.40	1.0	1.12	0.11
Complexity	0.18	0.30	0.89	1.0	0.10
CR = 0.013				$\sum$ Priority = 1.0	

Table 5: Pairwise Comparisons Judgment for the Sub-Characteristics According to 'Time to Use (TU)' , 'Time to Configure (TC)' and Priority (P)

Learnability	TU	TC	P
Time to Use	1.0	2.0	0.67
Time to Configure	0.5	1.0	0.33
CR = 0.0			$\sum$ Priority = 1.0

Table 6: Pairwise Comparisons Judgment for the Sub-Characteristics According to 'Documentation' (D), 'Training' (T), and 'Support' (S) and Priority (P)

Understandability	D	T	S	P
Documentation	1.0	2.0	2.0	0.50
Training	0.50	1.0	1.0	0.25
Support	0.50	1.0	1.0	0.25
CR = 0.0			$\sum$ Priority = 1.0	

Table 7: Pairwise Comparisons Judgment for the Sub-Characteristics According to 'Effort for Operating' (EO)and 'Administrability'(A) and Priority(P)

Operability	EO	A	P
Effort for Operating	1.0	0.5	0.33
Administrability	2.0	1.0	0.67
CR = 0.007			$\sum$ Priority = 1.0

About 'Complexity', a weight value one is assigned to the attribute 'Required Interface' because the 'Complexity' sub-characteristic is decomposed into one attribute.

4 Weights Generation Methods with SAW Approach in the AHP

The SAW method is used to rank the various database software options. The two database components, Oracle 9i and SQL Server 2005 are used to illustrate this step of our technique. The overall weights of each criterion and Sub-Criteria (Learnability, Understandability, Opreatability, and Complexity). Time to use, Time to configure, Documentation, Training, Support, Effort for operating, Administrability, and Required interface) are calculated by AHP and can thus be used as input to the SAW method, as shown in Table 8. As an outcome, using the scale in Table 1, decision-makers are asked to evaluate the alternatives based on each sub-criterion. as illustrated in Table 9 and Table 10, below.

Table 8: Input Values of the SAW Analysis

	TU	TC	D	T	S	EO	A	RI
Oracle 9i	5	8	7	8	8	6	8	5
SQL Server 2005	8	7	5	9	6	8	6	6
Weight	0.3484	0.1716	0.135	0.0675	0.0675	0.0363	0.0737	0.10

Table 9: The Normalized Sub-Criteria Weightings Weight (W) , Sub-Criteria(SC) , Weight(W) and Level Two(LT)

Criteria	W	SC	W	LT
Learnability	0.52	Time to Use	0.67	0.3484
		Time to Configure	0.33	0.1716
Understandability	0.27	Documentation	0.50	0.1350
		Training	0.25	0.0675
		Support	0.25	0.0675
Operability	0.11	Effort for Operating	0.33	0.0363
		Administrability	0.67	0.0737
Complexity	0.10	Required Interface	1.0	0.1000
	$\sum$ Weight =1.0			$\sum$ Level Two =1.0

Table 10: The Normalized Sub-Criteria 'Weightings' Time to Use (TU), Time to Configure (TC), Documentation (D), Training (T), Support (S), Effort for Operating (EO), Administrability (A) and Required Interface (RI)

	TU	TC	D	T	S	EO	A	RI
Oracle 9i	5	8	7	8	8	6	8	5
SQL Server 2005	8	7	5	9	6	8	6	6
Weight	0.3484	0.1716	0.135	0.0675	0.0675	0.0363	0.0737	0.10

The second step is to calculate $xij/Max(xij)$ for each column associated with Oracle 9i and SQL Server, as illustrated in Table 11, below.

5 Results and Discussion

The result of the preference value (Vi) for Oracle 9i is the summation ($\sum$) of multiplying each element on the first row ($R1j$) by the corresponding weight in the third row ($W3j$)As shown in Figure 3. In the same way, the result of the preference value (Vi) for SQL Server 2005 is the summation ($\sum$) of multiplying each element in the second row ($R2j$) by the corresponding weight in the third row ($W3j$). The following formula 3 generalizes the computational concept for any number of OS components, as described in Section 4 above.

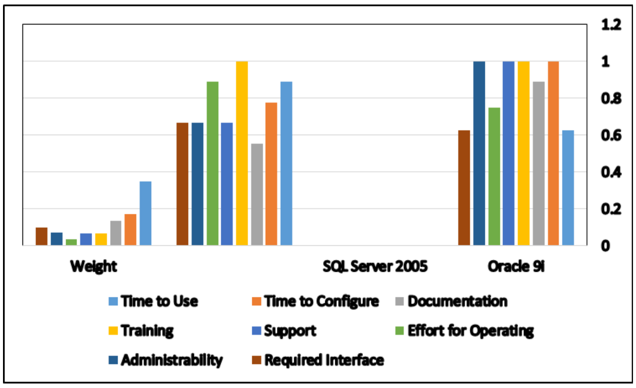

Figure 3: Final Software Attributes.

$Vi = \sum wkjrij \; i = 1 \ldots n, j = 1 \ldots m$, Where: (k) is the last row number in the matrix, (n)The number of OS components under the evaluation process, and (m).The total number of the corresponding characteristics and sub-characteristics. After computing the normalized priority weights for each Pairwise Comparison Judgment Method (PCJM) of the Integrated AHP-SAW Methodology, the solution to the database selection issue is synthesized. The normalized local priority weights of the characteristics, sub-characteristics, and attributes are combined to generate the global composite priority weights, as indicated in Section VII above. Accordingly, for Oracle 9i, the formula will be applied as follows: $V1 = \sum w3jrij \; i = 1, j = 1 \ldots 8$ $V1 = 0.828$ On the other hand, for SQL Server 2005, the formula will be applied as follows: $V2 = \sum w3jrij$ $i = 2, j = 1 \ldots 8$ $V2 = 0.779$ As can be seen, Oracle 9i is the clear victor of this assessment procedure and hence the best OS database component. As a result, by applying the hybrid technique of AHP and SAW and creating a numeric preference value that helps decision-making, our methodology overcomes the restriction of prior work as described in the Literature Review. The proposed methodology's determination is to locate the best database software component among those with access to commercial off-the-shelf (POS) systems by utilizing a suitable decision-making procedure. After testing the aggregations on various process parameters under various conditions, as shown in Sections 3.2 and 3 above.

6 Conclusions

Our contribution presents an approach application based on a hybrid multi-criteria decision-making process.For order preference, Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) is used. Even though our testing sample only in-

Table 11: Calculation of $xij/Max(xij)$ for Each Column

	TU	TC	D	T	S	EO	A	RI
Oracle 9i	0.625	1.0	0.889	1.0	1.0	0.75	1.0	0.625
SQL Server 2005	0.889	0.778	0.556	1.0	0.667	0.889	0.667	0.667
Weight	0.3484	0.1716	0.135	0.0675	0.0675	0.0363	0.0737	0.10

cluded two OS components, the proposed methodology can be applied to any other software selection problem involving multiple OS components and multiple and conflicting criteria [13]; [25]. Furthermore, the hybrid concept in our model, as well as the fact that the preference indication is computed as an explicit numeric value, facilitates decision-making and overcomes the limitations mentioned in the Literature Review Section. MCDM methodologies for further work include Elimination Et Choix Traduisant la Realties' (elimination and choice expressing reality – (ELECTRE)), Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH), Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), Viekriterijumsko Kompromisno Rangiranje (VIKOR), and (TOPSIS). Each of these techniques can be integrated with AHP and used to conduct a comparison based on 'Usability' in the same way that this research work has. We think that evaluating and investigating the various outcomes will yield valuable advice for organizational decision-makers. Furthermore, investigating AHP in a fuzzy environment might be a fascinating area of research [15]. The suggested methodology's pair-wise comparison is inadequate and imprecise to capture the decision-makers specific judgements, which is a significant drawback. In this regard, the approach may be examined in the context of a fuzzy environment to overcome such constraints.

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