Analysis of Challenges to Improve Jordanian National Database for Researches

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Abstract: The Jordanian national database for researchers (JNDBR) aims at documenting all academic staff research studies concerned with issues related to Jordanian community. This database includes information about Jordanian research studies published by Jordanian researchers inside and outside Jordan. This database will facilitate the process of research utilization and production, access and dissemination of information knowledge. Further, the JNDBR will assist researcher in general researchers in particular in identifying priority areas that need further investigation which will consequently improve education and practice in Jordan.

The consistency issue is one of the hot research topics in the analytic hierarchy process (AHP) and analytic network process (ANP). To identify the most inconsistent elements for improving the consistency ratio of a reciprocal pair wise comparison matrix (PCM), a bias matrix can be induced to efficiently identify the most inconsistent elements, which is only based on the original PCM. The goal of this paper is to conduct a questionnaire which include pair wise comparison between the challenges that face the JNDBR improving, a decision matrix will be obtained and a consistency analysis will be provided in order to fined the consistent rank of each challenge.

Keywords: Decision matrix, normalized decision matrix, priority vector, priority Eigen value, consistency index, consistency ratio.

1. Introduction

The existing studies suggested the Use Case based Goal oriented Requirements Engineering (GoRE)[1,2]. This method has the goal to reflect the exact customers’ requests in developing software. However, in this method, customers subjectively judged and decided ERRC of Use Case according to the judgment standard of Hybrid Approach [1,2]. Moreover, it is very difficult for customers to judge the extracted Use Case whether it is correct or not. In order to solve such a problem, this paper extracts the importance of Use Case with AHP, and prioritizes them,
it judges whether the major idea is consistently determined or not through the estimation of AHP consistency.

2. Related works

AHP, which was developed by T. Saaty [7, 8], performs the pair wise comparison between categories composing the decision hierarchy. It accomplishes the assessor’s consistency estimation with such a pair wise comparison. Accordingly, it can decide human being’s subjective judgment reasonably [4]. The UCP technique [3, 4], which was developed by Gustav Karner in 1993, estimates the software size of the object oriented systems [4, 5]. The UCP method is based on similar principles as Function Point (FP) software estimation method, but was created to solve for the specific needs of object oriented systems and system requirements based on use cases [3, 4].

Many tools can be used to analyze data sets such as artificial neural networks, data regression [9], [10] and [11], these tools can be used to find the relationship between 2 or more sets of data and to predict the output knowing the input data sets, Here in this paper we will introduce a tool which is defer and it be suitable to measure the input data set consistency before going to any tool of data analysis.

3. Data collection

Data collection step was performed according to the following steps:

1- We set the most important challenges (categories) that face JNDBR, these challenges are illustrated in table 1.

Table 1: Challenges that face JNDBR

<table>
<thead>
<tr>
<th>Challenge number</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provided services</td>
</tr>
<tr>
<td>2</td>
<td>Used interface</td>
</tr>
<tr>
<td>3</td>
<td>Information value</td>
</tr>
<tr>
<td>4</td>
<td>Hardware</td>
</tr>
<tr>
<td>5</td>
<td>Software</td>
</tr>
<tr>
<td>6</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>7</td>
<td>Planning and development</td>
</tr>
<tr>
<td>8</td>
<td>Support and maintenance</td>
</tr>
</tbody>
</table>
2- We conduct a special pair wise comparison questionnaire which is shown in figure 1.

3- The questionnaires were distributed a among 500 Jordanian universities academics to be filled.

4- The results of filled questionnaires were treated and weighted in order to obtain decision table which is shown in figure 2.

<table>
<thead>
<tr>
<th>A - Importance - or B?</th>
<th>Equal</th>
<th>How much more?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
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<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
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<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
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<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
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<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
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<td>2 3 4 5 6 7 8 9</td>
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<tr>
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<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>Provided services</td>
<td>1</td>
<td>2 3 4 5 6 7 8 9</td>
</tr>
</tbody>
</table>
Consistency analysis is very useful in finding the consistency ratio (CR) and the rank of each category involved in the study\cite{1, 2].

The consistency analysis can be done and different data structures can be calculated according to following sequence of steps:

**step 1:** Finding the normalized version of the decision matrix

To do this we sum each column in the decision matrix(A) and divide each element in the decision matrix by its column sum and here are the results of this step:
The sums of decision matrix column (vector S) were as follows:

<table>
<thead>
<tr>
<th></th>
<th>2.6800</th>
<th>7.8700</th>
<th>5.3300</th>
<th>22.0000</th>
<th>24.0000</th>
<th>16.0000</th>
<th>13.0000</th>
<th>14.0000</th>
</tr>
</thead>
</table>

The obtained normalized decision matrix was:

<table>
<thead>
<tr>
<th></th>
<th>0.3731</th>
<th>0.3812</th>
<th>0.3752</th>
<th>0.3838</th>
<th>0.3780</th>
<th>0.3780</th>
<th>0.3077</th>
<th>0.3571</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1231</td>
<td>0.1271</td>
<td>0.0338</td>
<td>0.2273</td>
<td>0.2500</td>
<td>0.1280</td>
<td>0.1538</td>
<td>0.1429</td>
</tr>
<tr>
<td></td>
<td>0.1866</td>
<td>0.2591</td>
<td>0.1076</td>
<td>0.1010</td>
<td>0.1667</td>
<td>0.1875</td>
<td>0.1555</td>
<td>0.1429</td>
</tr>
<tr>
<td></td>
<td>0.0443</td>
<td>0.0254</td>
<td>0.0489</td>
<td>0.0485</td>
<td>0.0417</td>
<td>0.0625</td>
<td>0.0769</td>
<td>0.0714</td>
</tr>
<tr>
<td></td>
<td>0.0410</td>
<td>0.0215</td>
<td>0.0499</td>
<td>0.0455</td>
<td>0.0417</td>
<td>0.0625</td>
<td>0.0769</td>
<td>0.0714</td>
</tr>
<tr>
<td></td>
<td>0.0634</td>
<td>0.0635</td>
<td>0.0619</td>
<td>0.0455</td>
<td>0.0417</td>
<td>0.0625</td>
<td>0.0769</td>
<td>0.0714</td>
</tr>
<tr>
<td></td>
<td>0.0933</td>
<td>0.0635</td>
<td>0.0338</td>
<td>0.0485</td>
<td>0.0417</td>
<td>0.0625</td>
<td>0.0769</td>
<td>0.0714</td>
</tr>
<tr>
<td></td>
<td>0.0746</td>
<td>0.0635</td>
<td>0.0338</td>
<td>0.0455</td>
<td>0.0417</td>
<td>0.0625</td>
<td>0.0769</td>
<td>0.0714</td>
</tr>
</tbody>
</table>

**Step 2:** Calculating priority vector.

The normalized principal Eigen vector which is called priority vector (PV), since it is normalized, the sum of all its elements equal to one. The priority vector shows the relative weights between the categories which are to be compared. To obtain priority vector we have to take the average of each row sum in the normalized decision matrix and the result of implementing this step is as follows:

Priority vector:

<table>
<thead>
<tr>
<th></th>
<th>0.3635</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1554</td>
</tr>
<tr>
<td></td>
<td>0.1826</td>
</tr>
<tr>
<td></td>
<td>0.0519</td>
</tr>
<tr>
<td></td>
<td>0.0509</td>
</tr>
<tr>
<td></td>
<td>0.0609</td>
</tr>
<tr>
<td></td>
<td>0.0665</td>
</tr>
<tr>
<td></td>
<td>0.0662</td>
</tr>
</tbody>
</table>

**Step 3:** Calculating Priority Eigen value (Check the approximation error)

Priority Eigen value (PEV) can be obtained by summation of the products of the vectors B and PV.

\[ \text{PEV} = \]

8.3269

To check whether our approximation is closed to largest Eigen value we find the largest lambda by applying:

\[ [W,L] = \text{eig}(A) \]
\[
\text{max} \left( \text{max} \left( L \right) \right)
\]

\[
\text{ans} = 2.2366
\]

Which is very close to approximation value with a small error = 1.0614%

**Step 4:** Calculating Consistency index (CI).

To do this we have to:

- Find the product \( P \) of the vectors \( A \) and \( PV \).
- Divide each element of \( P \) by the corresponding element in \( PV \).

The results of this step are as follows:

\[
\text{CE} = \\
\begin{bmatrix}
8.3604 \\
8.5153 \\
8.1250 \\
6.0729 \\
6.0595 \\
8.1872 \\
6.1425 \\
6.1546 \\
\end{bmatrix}
\]

**Step 5:** Consistency ratio (CR)

Consistency ratio can be calculated as follows:

- Find the average sum of consistency index: \( L1 = \frac{\text{sum}(\text{sum(CE))}}{8}; \)

\[
\text{CI} = \frac{\text{abs}(L1-8)}{(8-1)};
\]

- Divide CI by a random index given from the table 2: \( CR = \frac{\text{CI}}{1.41} \)

To check the consistency we have find the consistency ratio and it must be less than 10% according to (Saaty, T. 2000).

The results of this step

\[
CR = 0.0243 \text{ which is 2.4% and it is acceptable.}
\]
Table 2: Random index (RI) depending on the number of categories

<table>
<thead>
<tr>
<th>n</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.9</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
</tr>
</tbody>
</table>

The following MATLAB code was written and implemented to perform the analysis phase.

```matlab
clc
clear all

% Border example
A=[ 1 3.00 2.00 8.00 9.00 6.00 4.00 5.00
    0.33 1 0.50 5.00 6.00 2.00 2.60 2.00
    0.50 2.60 1 4.00 4.00 3.00 2.60 2.00
    0.12 0.20 0.25 1 1.00 1.00 1.00 1.00
    0.11 0.17 0.25 1.00 1 1.00 1.00 1.00
    0.17 0.50 0.50 1.00 1.00 1 1.00 1.00
    0.25 0.50 0.50 1.00 1.00 1.00 1.00 1.00
    0.20 0.50 0.50 1.00 1.00 1.00 1.00 1.00];

% STEP 1
% Normalize the Decision Matrix by
% 1- Find the sum of each row
% 2- Divide each element in the DM by its column sum
% B=sum(A)
for i=1:m
    for j=1:n
        Na(i,j)=A(i,j)/B(j);
    end
end
Na

% STEP 2
% Get the sum of each row and divide it by n\(m=0) \) to obtain priority matrix
% PV=sum(Na\(i\));
% PV=PV/8;
pv=pv
% Find principal eigen value
% PEV=0;
% for i=1:n
%     PEV=PEV+B(i)^PV(i,1);
% end
% PEV
% Get Lambda
% [L1,L2]=eig(A);

% Find the error
err=(abs((PEV-max(max(L1)))/PEV)*100
% Step 3
% Calculate consistency index
CI=PEV
for i=1:n
    CE(i,1)=CE(i,1)/PV(i,1);
end
CE
% Consistency ratio
CR=(max(abs(CE))/B2;
CI=abs(L1-B2)/B2;
CR=CI/1.11
```
5- Results Discussions

During the analysis process some data structures we obtained and the consistency of study was proved by:

- The approximation Eigen value was very closed to the calculated one.

- The consistency ration was less than 10% which mean that the ranking (consistency index) is acceptable.

- According to the values of consistency index the challenges can be ranked as shown in figure 3.

<table>
<thead>
<tr>
<th>Category</th>
<th>Priority</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Provided services</td>
<td>36.5%</td>
<td>1</td>
</tr>
<tr>
<td>2 Used interface</td>
<td>15.8%</td>
<td>3</td>
</tr>
<tr>
<td>3 Information value</td>
<td>18.5%</td>
<td>2</td>
</tr>
<tr>
<td>4 Hardware</td>
<td>5.0%</td>
<td>7</td>
</tr>
<tr>
<td>5 Software</td>
<td>4.9%</td>
<td>8</td>
</tr>
<tr>
<td>6 Infrastructure</td>
<td>6.0%</td>
<td>6</td>
</tr>
<tr>
<td>7 Planning and development</td>
<td>6.7%</td>
<td>4</td>
</tr>
<tr>
<td>8 Support and maintenance</td>
<td>6.5%</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 3: Ranking JNDBR challenges

6- Conclusions

A set of challenges that face the process of improving JNDBR were conducted. A core data was collected and analyzed. The challenges were ranked and the consistency was proved which leads to the ranking process acceptance.

References