Fuzzy Analytical Hierarchical Process Model and ICT Maturity Model of SMES for ICT Maturity Measurement of Nigerian Service Firms

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ABSTRACT
A key challenge within the service industry is how the benefits from ICT adoption and diffusion (ICT value) relate to the degree of adoption and diffusion of ICT (ICT maturity). This has resulted in the uncertainty of value generation from investments on ICT leading to ICT mis-planning and disaster. For sustainable improvement of ICT based service delivery in Nigeria therefore, the ICT maturity index of the Nigerian service industry has to be measured. The ICT maturity of selected service firms listed in the Nigerian Stock Exchange (NSE) has been measured adapting the ICT Maturity model of Small-and-Medium Enterprises (SMEs) by using the Fuzzy Analytical Hierarchical Process (FAHP) model to determine the weights of the four main factors that constitute the ICT maturity model against the original equal weighting of the factors. The result showed that the Nigerian service industry is web based in ICT maturity with an index of about 0.74.

Keywords: Service industry, Nigeria, ICT maturity, ICT maturity model and FAHP

1. INTRODUCTION
A key challenge within the service industry is to improve the understanding of how managers actually perceive the benefits from ICT adoption and diffusion (ICT value), and how this relates to the actual level of ICT adoption and diffusion (ICT maturity) reminiscent of the productive investments on ICT. This research work addressed this challenge. This is particularly important considering the fact that as with the developed nations of the world; the service industry is the largest contributor to the wealth of the Nigeria economy; presently the largest in Africa and 26th largest in the world. It accounts for about 51% of Nigeria’s gross domestic product – GDP [1].

ICT maturity models are increasingly being applied within the field of service science, both as an informed approach for continuous improvement and as a means of self or third-party assessment of service organization [2]. ICT maturity models when applied to service department(s) can show how structured, ordered and focused they are towards the provision of service(s) to their customer(s); using ICT facilities [3]. Furthermore, it can guide in the continuous improvement of ICT facilities and services of a service department(s) [4,5]. To this end, using the ICT maturity model of SMEs, this paper measured the ICT maturity of the Nigerian Service Industry as a possible panacea towards unravelling the uncertainty of value generation from investments on ICT.

Pham [6] did a similar work for some Vietnamese SMEs while Chan et al. [7] did also for selected companies in mainland China. This ICT maturity model as implemented by Pham [6] and Chan et al. [7], is very easy to implement but assign equal weights to the criteria involved in the decision making process (see equation 10). These weights play a vital role in decision making process and extremely affect the final decision [8]. In reality however, some criteria are more important than others towards determining the maturity of ICT in firms. Besides, possible respondent’s imprecision and uncertainty in filling the questionnaires is not accommodated. Consequently, this paper uses the Fuzzy Analytical Hierarchical Process (FAHP) model to determine the criteria weights as against the use of equal weights as in Pham [6] and Chan et al. [7]. The FAHP is an extension of Analytical Hierarchical Process (AHP) to accommodate risk and uncertainty.

2. ANALYTIC HIERARCHICAL PROCESS (AHP) MODEL
Analytic Hierarchy Process (AHP) model was introduced by Saaty [9] to solve complicated multi-criteria decision problem. Besides, AHP is appropriate whenever a target is obviously declared and a set of relevant criteria and alternatives are offered [10]. AHP is an ideal method for ranking alternatives when multiple criteria and sub-criteria are present in the decision-making process [11]. AHP is a popular model to aggregate multiple criteria for decision making [12]. AHP allows the decision-maker to structure complicated problems in the form of a decision hierarchy.
The hierarchy usually consists of three different levels, which include goals, criteria, and alternatives as depicted in Figure 1.

Figure 1.1: Structure of AHP

The AHP process begins by determining the relative importance of the criteria in meeting the goals. Next, the focus shifts to measuring the extent to which the alternatives achieve each of the criteria. Finally, the results of the two analyses are synthesized to compute the relative importance of the alternatives in meeting the goal. Managerial judgments are used to drive the AHP approach [13]. These judgments are expressed in terms of pair-wise comparisons of items on a given level of the hierarchy with respect to their impact on the next higher level. Pair-wise comparisons express the relative importance of one item versus another in meeting a goal or a criterion. Each of the pair-wise comparisons represents an estimate of the ratio of the weights of the two criteria being compared. Because AHP utilizes a ratio scale for human judgments, the alternatives weights reflect the relative importance of the criteria in achieving the goal of the hierarchy [14].

The use of the AHP approach offers a number of benefits. One important advantage of AHP is its stability and flexibility regarding changes within, and additions, to the hierarchy. In spite of the benefit of AHP, it also has some weak points. One of these is the complexity of this method which makes its implementation quite inconvenient. A further disadvantage of this method is that it does not consider risks and uncertainties [14].

To make a decision in an organised way to generate priorities we need to decompose the decision into the following steps as proposed by Saaty [9]:

1. Define the problem and determine the kind of knowledge sought.
2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).
3. Construct a set of pair-wise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.
4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

2.1 Fuzzy Analytical Hierarchical Process (FAHP) Model

In spite of the benefit of AHP [10,11,15], it has been criticized due to its inability to adequately handle uncertainty and imprecision associated with the mapping of the exact numbers [16]. The conventional AHP approach does not reflect human thinking for the simple fact that decision makers feel more confident to give interval judgments rather than express their judgments in the form of single numeric values and so Fuzzy Analytical Hierarchical Process (FAHP) is capable of capturing a human's appraisal of ambiguity when complex multi-attribute decision making problems are considered [17]. A new approach to a precise theory of approximation and vagueness based on generalization of standard set theory to fuzzy sets was introduced by Zadeh [18]. Since fuzziness and vagueness are common characteristics in many decision-making problems, a fuzzy AHP (FAHP) method should be able to tolerate vagueness or ambiguity [19].
Fuzzy sets and fuzzy logic are powerful mathematical tools for modelling nature and human behavior, uncertain systems in industry, and facilitators for common-sense reasoning in decision making in the absence of complete and precise information. Their role is significant when applied to complex phenomena not easily described by traditional mathematical methods, especially when the goal is to find a good approximate solution. Fuzzy set theory is an extension of classical set theory where elements have degrees of membership [18]. The theory of fuzzy set was a generalization of classic set theory which allows the membership functions to operate over the range of real numbers [0, 1]. The main characteristic of fuzziness is the grouping of individuals into classes that do not have sharply defined boundaries [20]. The uncertain comparison judgment can be represented by the fuzzy number. In the FAHP method, the pair-wise comparisons in the judgment matrix are fuzzy numbers and use fuzzy arithmetic and fuzzy aggregation operators. Triangular fuzzy numbers were introduced into the conventional AHP in order to enhance the degree of judgment of decision maker.

2.4.5 Triangular Fuzzy Number (TFN)
A triangular fuzzy number is a convex fuzzy set with a grade of membership between 0 and 1. It is a special class of fuzzy number whose membership is defined by three real numbers. In applications it is often convenient to work with TFNs because of their computational simplicity [21,22], and they are useful in promoting representation and information processing in a fuzzy environment [23]. Consequently, a succinct implementation of the FAHP model as given by [24] was adopted.

In the services science domain, ICT maturity is measured using standard models called ICT maturity models. The first ICT maturity model introduced was the Nolan’s model [25,26] and since it was introduced in the 1970’s, several ICT maturity models are now in use. They include: (i) Nolan ICT Maturity Model; (ii) UNESCO’S Model of ICT Maturity; (iii) Cloud ICT Maturity Model; (iv) Organization Interoperability ICT Maturity Model; (v) TOBI Maturity Model; (vi) Sustainable ICT Capability Maturity Framework (SICT-CMF); (vii) Accessibility Maturity Model; (viii) Green ICT Maturity Model; (ix) Knowledge Maturity Model and (x) the ICT Maturity Model of SMEs. Due to limited paper size and to keep the paper in focus, a detailed review of existing ICT maturity models is reported separately.

3. MATERIALS AND METHODS
The quasi-experimental research methodology was adopted. After a critical review and consultation, some 23 service firms listed in the NSE and a model each for ICT maturity and value measurement, were selected. The research then took two independent paths which later coalesced into the third and final part of the research. After a successful informal consultation with several service firms listed in the NSE to seek for permission to use their firms as a research case study, a total of 33 service firms gave consent but only 28 of them was actually accessible for the field work exercise which took place during the periods of 14th of April through 15th of May, 2015. The 28 firms are: Expert Edge Software, Main Street Bank, Bank of Industry, Skye Bank PLC, Zenith Bank PLC, Keystone Bank Limited, Access Bank PLC, Guaranteed Trust Bank PLC, First Bank Nigeria PLC, Union Bank PLC, Fast Credit Limited, Information Technology Transfer, Petrodata Management Services, Digital Communication Company, CHAMS PLC, Computer Warehouse Limited, ETISALAT Nigeria, Visafone Communications Limited, Airtel Nigeria, MTN Nigeria, SMILE Communications, STACO Insurance PLC and Zenith Insurance.

The field work exercise was a questionnaire survey meant to capture the necessary data to measure the ICT maturity of these firms. The questionnaires were given to the protocol officers of the various firms for distribution. As a result of the very busy schedule of the respondents, the questionnaires could not be filled and collected immediately on distribution; it sometimes took several days of series of attempts to get the distributed questionnaires back. A total of 252 questionnaires were distributed, nine questionnaires per firm. The firms were specifically instructed that the nine questionnaires should be distributed three each per levels of management namely operational, middle and top management levels. This is to avoid a possible pitfall of a related research by Chan et al. [7] for companies in mainland China where one questionnaire per firm was administered which may be to prejudice by the respondent’s position.

Distributing three questionnaires per managerial level did not only degrade the effect of position prejudice but also weakened bias within a managerial level. The average time a respondent spent on the questionnaire was about 15 to 20 minutes. Due to administrative protocols and the high traffic in Lagos, Nigeria, we could hardly visit five firms in a day. The second researcher carried out the questionnaire survey under the strict monitoring of the research leader via mobile phone calls and location tracking. A total of 156 questionnaires were validly returned.

The questionnaire modelled after the ICT Maturity Model of SMEs [6] is a three part document. The first part introduced and contained demographic data (name and type) of firm and respondents managerial position. The second part consist of 50 indicator questions grouped under the four major factors of observable capabilities of SMEs: Infrastructure (eleven indicator questions), Application (thirteen indicator questions), Human Resource (twelve indicator questions) and Policy (fourteen indicator questions). In addition, the last part of the questionnaire captured the respondents contact (mobile phone and e-mail address). Although questionnaires with similar connotations and indicator value have been used by Pham [6] and Pham [27], the research leader validated and approved this questionnaire for the research. Appendix A contains a sample questionnaire.
The questionnaires was then sorted and coded using the indicator stage value as proposed by Pham [6]. The ICT maturity index (ICTMI) was calculated using the formula in equation (1) as proposed by Pham [6].

\[
\text{ICTMI} = \alpha I + \beta A + \gamma H + \delta P \\
\text{Where}
\]

\[
0 \leq I, A, H, P, \text{ICTMI} \leq 1 \text{ and } \alpha + \beta + \gamma + \delta = 1; \text{ and}
\]

\[
I = \frac{\sum_{i=1}^{4}(\frac{\sum_{j=1}^{m} H_{ij}}{ml})}{4}, \quad A = \frac{\sum_{i=1}^{4}(\frac{\sum_{j=1}^{m} P_{ij}}{ml})}{4}, \quad H = \frac{\sum_{i=1}^{4}(\frac{\sum_{j=1}^{m} H_{ij}}{P_{ij}})}{4}, \quad P = \frac{\sum_{i=1}^{4}(\frac{\sum_{j=1}^{m} P_{ij}}{P_{ij}})}{4} \quad \ldots \ldots (2)
\]

\[
\text{Where}
\]

\[
I, A, H, P, \text{ and } \text{ICTMI are indicators of stage I; } nl, ml, pl \text{ and } ql \text{ are number of respective indicators of stage I.}
\]

Since no information of weighting I, A, H, P, Pham [6] let \( \alpha = \beta = \gamma = \delta = 0.25 \ldots \ldots (3) \)

This research frowns seriously at this use of equal weighting but instead used the FAHP [24, 27] to determine the value of \( \alpha, \beta, \gamma \text{ and } \delta. \) A Step by step procedure for implementing AHP as given by Aladeselu et al. [28] is presented as follows: Given the indicator factor values of firms which is in the form \( A = n \times m \) matrix where \( n \) denotes the number of criterion and \( m \) the number of firms. In our case, \( n = 4 \) and \( m = 23. \) Perform the following steps:

Step1: Perform column operation on each University column of matrix \( A. \)

For example, to obtain a column operation matrix for firm F1, we carry out the following column operation:

\[
\begin{bmatrix}
a_{11} & a_{12} & a_{13} & \ldots & a_{1n} \\
a_{21} & a_{22} & a_{23} & \ldots & a_{2n} \\
a_{31} & a_{32} & a_{33} & \ldots & a_{3n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & a_{m3} & \ldots & a_{mn}
\end{bmatrix}
\]

From the above operation, the result of the column operation will be of the form:

\[
A_k = \begin{bmatrix}
a_{11} & a_{12} & a_{13} & \ldots & a_{1n} \\
a_{21} & a_{22} & a_{23} & \ldots & a_{2n} \\
a_{31} & a_{32} & a_{33} & \ldots & a_{3n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & a_{m3} & \ldots & a_{mn}
\end{bmatrix}
\]

The above process is repeated for each of the firms.

Step2: Obtain judgement matrices \( A_{ij}, A_{ij}^M, A_{ij}^H, A_{ij}^P \) based on pair-wise comparison of all \( Ak \)

\[
A_{ij} = \sqrt{A_{ij}^M \times A_{ij}^H} \quad \text{ak and } i \neq j \text{ otherwise } A_{ij}^M = 1 \quad (5)
\]

where

\[
A_{ij}^M = \min (A_{ij}) \quad \forall \text{ak}
\]

\[
A_{ij}^H = \max (A_{ij}) \quad \forall \text{ak}
\]

Step3: Normalize each column of matrices \( A_{ij}^L, A_{ij}^M, A_{ij}^H, A_{ij}^P \) to get a new judgment matrix \( A^L, A^M, A^H \) respectively of the form:

\[
A^N = \begin{bmatrix}
a_{11} & a_{12} & a_{13} & \ldots & a_{1n} \\
a_{21} & a_{22} & a_{23} & \ldots & a_{2n} \\
a_{31} & a_{32} & a_{33} & \ldots & a_{3n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & a_{m3} & \ldots & a_{mn}
\end{bmatrix}
\]

Step4: Sum up each row of normalized judgement matrix \( A^N \) to get weight vector \( V. \)
Step 8: Define the final normalization weight vector $W$. 

$$W = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ \vdots \\ w_m \end{bmatrix}$$  \hspace{1cm} (14)

Step 9: For each $i = 1 \ (1) \ n$, compute matrix $A’$ 

$$W_{1} \ast A’_{ij} \forall \ j = 1 \ (1) \ m \hspace{1cm} (15)$$

Step 10: Compute vector $P_{j} = \frac{1}{\sum_{k} A’_{kj}} \forall \ j = 1 \ (1) \ m \hspace{1cm} (16)$

Step 11: Compute vector $R_{j} = \frac{P_{j}}{\sum_{k} P_{kj}} \forall \ j = 1 \ (1) \ m \hspace{1cm} (17)$

Step 12: $R_{j}$ defines the ranking of the firms.

This study made use of ICT maturity model of SMEs not only because it has been improved to be able to handle any category of enterprises but because it is simple, generic, quantifiable, popular, strongly aligned with modern business enterprises and yet powerful \cite{6, 7}.  

Ralian Communication Authority in 2008. It is based on four main factors: Infrastructure, Application, Human Resource and Policy. It originally consists of four phases namely: (i) Inactive; (ii) Basic; (iii) Substantial and; (iv) Sophisticated.
However, based on the above classification of ICT development in SMEs, [6] in consideration of recent development trends as well as conditions for knowledge management maturity, the ‘Sophisticated’ phase is suggested to be divided into two stages: Web-based and Knowledge-oriented.

Thus, we now describe this model as consisting of five phases as highlighted:

1. Inactive – no current use of ICT in company.
2. Basic – including word processing and other desktop packages.
3. Substantial – extending into the networking of PCs and several applications.
4. Web-based – extending to e-commerce with many web-based services.
5. Knowledge-oriented – integration of applications and using ICT tools for innovation and knowledge management.

Each of the maturity levels is characterized by certain observable capabilities of four major factors: Policy, Infrastructure, Application and Human Resource. Based on trend analysis of ICT use in SMEs, Table 1 maps the above five stages of ICT maturity in SMEs with its specific features.

<table>
<thead>
<tr>
<th>Maturity level</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Trend</td>
<td>Inactive</td>
<td>Basic</td>
<td>Substantial</td>
<td>Web based</td>
<td>Knowledge Oriented</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Connectivity &amp; Mobility</td>
<td>Telephone</td>
<td>PC, laptop</td>
<td>Network</td>
<td>Internet</td>
</tr>
<tr>
<td>ICT HR</td>
<td>Sophisticated &amp; Innovation</td>
<td>Unskilled</td>
<td>Business skills</td>
<td>Technology skills</td>
<td>MIS skills</td>
</tr>
<tr>
<td>Application</td>
<td>Integrated applications</td>
<td>No application</td>
<td>Office, E-mail</td>
<td>MIS applications</td>
<td>E-commerce</td>
</tr>
<tr>
<td>Policy</td>
<td>Flexibility &amp; Mobility</td>
<td>No policy</td>
<td>Standardize</td>
<td>Modernize</td>
<td>Cooperation</td>
</tr>
</tbody>
</table>

In general, it is very difficult for an enterprise to build up a knowledge system without appropriate ICT infrastructure and previous ICT applications. Moreover, to strengthen the competitive capability of SMEs, it is very important to apply appropriate ICT applications at the right time rather than adopting latest information systems. Therefore, the SMEs model allows a plan for improving ICT maturity towards Knowledge-oriented in order to use the knowledge resource effectively for future development.
4. RESULTS AND DISCUSSION

Table 2 captures the firms’ type and managerial level of the respondents in the respective firms’ type that took part in the questionnaire survey for measuring the ICT maturity of the Nigeria Service Industry.

Table 2: Summary of Service Firms’ Type and Operational Levels of Respondents

<table>
<thead>
<tr>
<th>TYPE OF FIRM</th>
<th>OPERATIONAL LEVEL</th>
<th>MIDDLE MANAGEMENT</th>
<th>SENIOR MANAGEMENT</th>
<th>TOTAL TYPE</th>
<th>% Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSULTANCY AND SERVICES</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>5.77%</td>
</tr>
<tr>
<td>BANKING</td>
<td>31</td>
<td>24</td>
<td>16</td>
<td>71</td>
<td>45.51%</td>
</tr>
<tr>
<td>TECHNOLOGY</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>33</td>
<td>21.15%</td>
</tr>
<tr>
<td>TELECOMMUNICATIONS SERVICES</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>30</td>
<td>19.23%</td>
</tr>
<tr>
<td>INSURANCE</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>13</td>
<td>8.33%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>68</td>
<td>50</td>
<td>38</td>
<td>156</td>
<td>100.00%</td>
</tr>
<tr>
<td>% of Managerial Level&gt;&gt;&gt;&gt;</td>
<td>43.59%</td>
<td>32.05%</td>
<td>24.36%</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows the spread of respondents across managerial levels and firms’ type. Most of the respondents are from the Banking sector (45.51%) and the respondents had a good spread across the three managerial levels with the operational level accounting for 43.59% of the respondents.

Table 3 captures the ICTMI of the various firms of the 23 service firms denoted as F_i, i=1(i)23; using equation (1) to equation (3). The average of these ICTMI is also captured in the table. The result in Table 3 shows that F1, for instance, has a total of 2.115162 of the maximum ICTMI index of 2.5. To map these ICTMI indexes to the ICT maturity levels of SMEs, they were quantized by a factor of 2.5 to realize Table 4. From Table 4, it easy to see that the average maturity of service firms in Nigeria is 0.763256 which by [6] stratification is web based. Thus, we can state that the ICT maturity of the Nigerian Service Industry is 0.76 i.e. web based.

Table 3: ICTMI of Selected Service Firms in Nigeria

<table>
<thead>
<tr>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.115162</td>
<td>2.21875</td>
<td>1.521205</td>
<td>1.675347</td>
<td>1.927083</td>
<td>1.989583</td>
<td>2.284375</td>
<td>1.888021</td>
</tr>
<tr>
<td>F9</td>
<td>F10</td>
<td>F11</td>
<td>F12</td>
<td>F13</td>
<td>F14</td>
<td>F16</td>
<td>F17</td>
</tr>
<tr>
<td>1.651042</td>
<td>1.413411</td>
<td>1.99375</td>
<td>1.895544</td>
<td>2.167245</td>
<td>2.155382</td>
<td>1.828451</td>
<td>2.209491</td>
</tr>
<tr>
<td>F18</td>
<td>F19</td>
<td>F19</td>
<td>F20</td>
<td>F21</td>
<td>F22</td>
<td>F23</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>2.13831</td>
<td>1.466146</td>
<td>1.467708</td>
<td>1.957465</td>
<td>2.06033</td>
<td>2.243634</td>
<td>1.619792</td>
<td>1.90814</td>
</tr>
</tbody>
</table>

Table 4: The Quantized ICTMI of Selected Service Firms in Nigeria

<table>
<thead>
<tr>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.846065</td>
<td>0.8875</td>
<td>0.608482</td>
<td>0.670139</td>
<td>0.770833</td>
<td>0.795833</td>
<td>0.91375</td>
<td>0.755208</td>
</tr>
<tr>
<td>F9</td>
<td>F10</td>
<td>F11</td>
<td>F12</td>
<td>F13</td>
<td>F14</td>
<td>F16</td>
<td>F17</td>
</tr>
<tr>
<td>0.660417</td>
<td>0.565365</td>
<td>0.7975</td>
<td>0.758218</td>
<td>0.866898</td>
<td>0.862153</td>
<td>0.73138</td>
<td>0.883796</td>
</tr>
<tr>
<td>F18</td>
<td>F19</td>
<td>F19</td>
<td>F20</td>
<td>F21</td>
<td>F22</td>
<td>F23</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>0.855324</td>
<td>0.586458</td>
<td>0.587083</td>
<td>0.782986</td>
<td>0.824132</td>
<td>0.897454</td>
<td>0.647917</td>
<td>0.763256</td>
</tr>
</tbody>
</table>

Due to possible bias and uncertainty on the part of the respondents, the FAHP steps as presented by Ekuobase et al. [24] are faithfully implemented to get a more reliable weighting value: α, β, γ, 0 as against the equal weighting of 0.25 each used to realize the ICTMI in Table 1.4. The resulting weighting values are as captured in Table 1.5.
Table 5: ICTMI weighting Coefficient using FAHP

<table>
<thead>
<tr>
<th>Weighting</th>
<th>FAHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.419189</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.14882</td>
</tr>
<tr>
<td>$\Gamma$</td>
<td>0.278186</td>
</tr>
<tr>
<td>$\Theta$</td>
<td>0.153805</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>

Observe that weighting values for AHP also added up to 1. Table 5 shows that the various weighting values were not equally distributed using AHP which is actually more reasonable and reliable. These weighting values were now used to compute the ICTMI for the various firms under investigation. The resultant ICTMI indexes are captured in Table 6.

Table 6: The Quantized ICTMI of Selected Service Firms in Nigeria using FAHP Weighting

<table>
<thead>
<tr>
<th></th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>F6</th>
<th>F7</th>
<th>F8</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>0.828547</td>
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</table>

Observe the minor variations between the ICTMI in Table 4 and that of Table 6 which altered the ranking of the various firms by ICTMI and puts the ICTMI of the Nigerian service industry at 0.74 against 0.76 estimated using the original equal weightings for $\alpha$, $\beta$, $\gamma$ and $\theta$.

5. CONCLUSION

A critical corporate performance and investment policy index – ICT maturity index, hitherto not existing, for the Nigeria Service industry has been estimated. The ICT maturity index of the Nigerian Service Industry was estimated to be about 0.74 i.e. the Nigerian Service Industry is Web based in ICT maturity. Managers of the Nigerian service industry are now better positioned towards a sustainable improvement of ICT based service delivery in Nigeria.

REFERENCES

APPENDICES : Questionnaires

Information and Communication Technology (ICT) Maturity Assessment
Questionnaire
GENERAL INSTRUCTIONS
Please answer the questions by drawing a circle around an appropriate number or alphabet in the space provided.

Please use the code where appropriate:
Yes definitely (Y); Yes, but not Significantly (S); No, but Probably within the next 5 years (P); No (N).

Unless specifically instructed otherwise, please answer all questions, one answer per item.

1. What is the name of the organization on whose behalf you are answering this Questionnaire?

2. What is the type of organization being assessed?

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles/ Transport</td>
<td>1</td>
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<tr>
<td>Banks</td>
<td>2</td>
</tr>
<tr>
<td>Capital Goods</td>
<td>3</td>
</tr>
<tr>
<td>Chemicals</td>
<td>4</td>
</tr>
<tr>
<td>Construction, Building, Materials and Steel</td>
<td>5</td>
</tr>
<tr>
<td>Consumer Goods</td>
<td>6</td>
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<tr>
<td>Insurance</td>
<td>7</td>
</tr>
<tr>
<td>Consultancy and Services</td>
<td>8</td>
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<tr>
<td>Oil and Gas</td>
<td>9</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>10</td>
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<tr>
<td>Technology</td>
<td>11</td>
</tr>
<tr>
<td>Telecommunications Services</td>
<td>12</td>
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<tr>
<td>Utilities</td>
<td>13</td>
</tr>
<tr>
<td>Retailers and Distributors</td>
<td>14</td>
</tr>
<tr>
<td>Other (please specify below)</td>
<td>15</td>
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</table>

3. Please specify the level of management being assessed?

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<tr>
<th>Level of Management</th>
<th>Code</th>
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<tbody>
<tr>
<td>Operational level</td>
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<tr>
<td>Middle management</td>
<td>2</td>
</tr>
<tr>
<td>Senior management</td>
<td>3</td>
</tr>
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</table>

V1

V2

V3
### SECTION 1: ICT INFRASTRUCTURE INFORMATION

1.1 Number of fixed telephone. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200

1.2 Number of business mobile devices (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200

1.3 Number of computers (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200

1.4 Type of Internet access. (a) No Internet (b) Dial up (c) ADSL (d) ISDN (e) cable modem (f) Leased line (g) Satellite (h) Others _______

1.5 Have Local area network (LAN). Y; S; P; N

1.6 Internet bandwidth (mbps). (a) Unknown (b) < 8mbps (c) < 16mbps (d) < 32mbps (e) >= 32mbps

1.7 Secure Internet Server/ Hosting. Y; S; P; N

1.8 Security & backup system. Y; S; P; N

1.9 Wide area network (WAN). Y; S; P; N

1.10 Wireless LAN/ wifi Internet. Y; S; P; N

1.11 Company information/services could be accessed through WAP/ i-mode access. Y; S; P; N

### SECTION 2: ICT APPLICATION INFORMATION

2.1 Standard application software. (a) Not use (b) Office software (c) CAD/CAM (d) Database (e) others _____________

2.2 Using Internet for getting information. Y; S; P; N

2.3 Website presence. Y; S; P; N

2.4 Internet Services which is used or provided (a) No service (b) Searching (c) Ordering (d) Purchasing (e) Marketing & sale (f) Customer support (g) intra-communications (h)inter-communications (i) Others ______

2.5 Online payment system. Y; S; P; N

2.6 Customer understanding/e-Marketing. Y; S; P; N

2.7 E-mail/ IM for communication. Y; S; P; N

2.8 Forum/ Social Network for cooperate use Y; S; P; N

2.9 Remote Meeting/ Voice Conference. Y; S; P; N

2.10 Using services through Intranet/ Extranet. Y; S; P; N

2.11 Management Information Systems. (a) No use (b) Finance-Accounting (c) Human Resource Management (d) Document Management (e) Assets Management (f) Inventory Management (g) Decision Support System (DSS)

2.12 Integrated Information Systems. (a) SCM (b) ERP (c) CRM (d) others_______

2.13 Knowledge Systems (a) Business Intelligent (b) Knowledge Base/KMS (c) Expert systems (d) other_________
SECTION 3: ICT HUMAN RESOURCE INFORMATION

3.1 ICT training. (a) Usually (b) Sometime (c) Rarely (d) Never
3.2 Number of employees using a computer. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.3 Number of employees using the Internet. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.4 Royalty payment & receipt. (a) No (b) The total amount is (NGN)____________
3.5 Patent/license application. (a)No (b) Number of application is____________
3.6 Company spending on R&D (NGN/year): __________ _____________________
3.7 Capacity for innovation. Y; S; P; N
3.8 Number of IT specified employee. (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.9 Separate IT department with Asst. Director/ Director. Y; S; P; N
3.10 Number of Business specified employee (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.11 Employees with self-learning skill (a) 1 – 10 (b) 11 – 50 (c) 51 – 100 (d) 101 – 200 (e) over 200
3.12. Capacity for Expertise Reuse. Y; S; P; N

SECTION 4 ICT POLICY INFORMATION

4.1 ICT investment budget/development budget (NGN/year): (a) 5% (b) 5% – 15% (c) 16% - 30% (d) over 30%
4.2 Quality policy. (a) No quality policy (b) ISO (c) CMMI (d) Others ____________
4.3 Privacy policy. (a) No (b) ISO (c) CMMI (d) Others ____________
4.4 Regulatory quality. (a) Good (b) Fair (c) Not Good (d) Bad
4.5 Security policy. (a) Good (b) Fair (c) Not Good (d) Bad
4.6 Piracy policy. (a) Good (b) Fair (c) Not Good (d) Bad
4.7 Upgrade ICT hardware/ software. (a) Annually (b) 2-year period (c) 3-year period (d) No policy
4.8 Assessment effectiveness. (a) Good (b) Fair (c) Not Good (d) Bad
4.9 ICT policy in company strategy. (a) Good (b) Fair (c) Not Good (d) Bad
4.10. your organization regards ICT and the management thereof as… (a) An enabler of knowledge management (b) Knowledge management
4.11. In your organization, the following Information management tools and services have been institutionalized:

<table>
<thead>
<tr>
<th>No</th>
<th>Information tools/services</th>
<th>Y</th>
<th>S</th>
<th>P</th>
<th>N</th>
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<tbody>
<tr>
<td>1</td>
<td>Inventory of information entities</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Information management systems</td>
<td>Y</td>
<td>S</td>
<td>P</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>Databases</td>
<td>Y</td>
<td>S</td>
<td>P</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>Information service / Library</td>
<td>Y</td>
<td>S</td>
<td>P</td>
<td>N</td>
</tr>
</tbody>
</table>

4.12. Knowledge Management based on ICT use is a priority. Y; S; P; N

Contact Name / Position _____________________________________________
Contact e-mail (to get survey result) __________________________________

Thank you very much for your cooperation, we are very grateful.
<table>
<thead>
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<th>V37</th>
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