Evaluation of role and effect of information technology on customer’s satisfaction in project-based organizations (PBO) with trend of business re-engineering process (BRP) case study: Ferma Company

Mohammadreza Motadel1, Reza Radfar2 and Vahid Fanipour3

1Faculty Member of Management Department in Islamic Azad University, Central branch of Tehran, Tehran, Iran.
2Faculty Member of Management Department in Islamic Azad University at Research & Science unit of Iran.
3Master of Information Technology, Islamic Azad University Virtual Unit, Tehran, Iran.

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ABSTRACT
A good insight of performance or execution in projects along with needed requirements of project management has the most important effect on customers’ satisfactions in a project-based organization. The performance result of each project in an organization has direct relationship with interaction manner of executive processes with project. In this paper, the combination of Delphi and Analytical Network Process (ANP) and Friedman Test have been applied to detect and rank the best strategy for improving customer’s satisfaction and determining its most important sub-indexes. Based upon obtained results, cost as the main area of project management has the most important effect on customer’s satisfaction in case of applying Information Technology (IT) in BRP of PBO, and the most important strategy in improving and boosting customers’ satisfaction in PBOs is BRP. Furthermore, IT and software are respectively the most important and considerable sub-indexes of structures and IT in BRP of PBOs.

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Theoretical fundamentals and research background
It’s been a long time that contractors do different sorts of projects. PBOs have defined customer’s satisfaction improvement as one of their significant goals in execution of a project. Costumer is defined as any person or organization that receives and enjoys produce or service of a group or organization (Armaki, E, 2006; Rowe, F, 2006; Geoffrey, B, 2006). “Costumers” in current research are defined as those who use services or products of Ferma Company.

Pursuant to the classification made by Project Management Institute, project management is subdivided into 9 areas (Muller, 2005; Suslloer, 2005; HL Castner, 2005):

- Project integration management
- Project scope management
- Project integration management
- Project time management
- Project cost management
- Project quality management
- Project human resource management
- Project communication management
- Project risk management
- Project procurement management

Many researchers have demonstrated that some areas have priority over the others among the said areas and paying enough attention to them may produce significant effects in achieving main goals of project execution. For evaluating costumer’s satisfaction, the influence of each area on the said issue should be assessed. There are also many ways for improving and boosting customer’s satisfaction through the mentioned areas. In PBOs, there are some infrastructures for establishing strategies; they themselves are included in some sub-indexes.
In 1990’s, BRP were introduced. BRP is known as a part of organization’s long-term change. In other words, this change is paraphrased as the change or shift of industrial age to information economics age by means of IT-based networks. The main difference between BRP and other recent management strategies is the fundamental change and basic improvement which is produced as the result of an organization’s activities. The other difference in relation with the mentioned issue is that implementing and positioning BRP is more complicated than other management strategies (Nolan, 2005; Krasno, 2005).

Delphi technique is a systematic method for solving problems in group form, which formed group of experts and knowledgeable persons, interacts with each other, but group idea can’t affect individuals’ ideas (PMBOK standard, 2004). For evaluating the trueness of first hypothesis (mentioned at the onset of paper), we used 30 knowledgeable persons’ ideas for determining the most effective areas of project management that can have the greatest effect on costumer’s satisfactions in case of using IT in BRP of PBOs. Then, with help of these knowledgeable persons, we repetitively took action to recognize/identify existing strategies for improving customer’s satisfactions to determine the most important strategy for improving customer’s satisfactions in PBOs. ANP method and Super Decision software were used to determine the most important strategy among offered strategies. For this reason, we used tables of priority determination, the mean of knowledgeable persons’ ideas, and determination of corresponding numbers with priorities for executing ANP model in the software.

ANP method is one of the decision-making models which are applied in every model because of numerous amounts of effective factors and variables (Pozzebon, 2004).

Friedman Test is a non-parametric test which is equal to analysis of variance with repetitive sizes (intergroup) and is used for comparing ranks among groups. For the purpose of analyzing collected data from statistical sample, deductive statistical techniques such as Delphi and Friedman ranking (for the first hypothesis), ANP method (for the second hypothesis) and Friedman raking test (for the third and fourth hypotheses) were used.

Conceptual model survey

The scope of each areas of project management’s effect should be determined and assessed to appraise costumer’s satisfactions. There are also several different solutions (or strategies) for improving customer’s satisfactions through above-mentioned areas. There are some infrastructures for establishment of solutions in PBOs that they themselves are subdivided into some sub-indexes. Analytical model of survey in phase zero was shown in figure 3 according to this explanation. See figure 3.

![Figure 3: Analytical model of survey in phase zero.](image)

Questions and survey hypotheses

According to the fact that the goal of this survey is identification of structural sub-indexes in BRP of PBOs (by applying IT to improve customer’s satisfactions) and also determining the most important of them, questions about the survey are as following:

- What is the most important area of project management that can have the greatest impact on scope of customer’s satisfactions if IT is applied in BRP of PBOs?
- What is the most important strategy or solution for improving customer’s satisfactions in PBOs?
- What is the most important sub-index of structural infrastructures for BRP of PBOs?
- What is the most important sub-index of IT infrastructures for BRP of PBOs?

According to set questions in above part, related hypotheses of this survey are as following:

- Cost as the area of project management has the most important effect on customer’s satisfaction in case of using IT in BRP of PBOs.
- BRP is the most important strategy for improving customer’s satisfactions in PBOs.
- IT is the most important structural infrastructure in BRP of PBOs.
- Software is the most important infrastructure of IT in BRP of PBOs.

Survey Methodology

This survey is counted as a descriptive and as a branch of measurement from the viewpoint of goal, application and also from the viewpoint of data collection and entity.

In this survey, using questionnaire is the method of collecting field data. The questionnaire were given to 30 knowledgeable persons in order to find out what are their ideas about the scope of importance and the effect of each of different areas of project management on costumer’s satisfactions and also the most important strategy among existing strategies.

Based upon obtained results from interviews with the said knowledgeable persons, it was took action to prioritize areas of project management by using Delphi method and comparison of mean of ideas. Friedman ranking test was applied to determine the most important area of project management in case of applying IT in BRP of PBOs which produces the greatest effect on customer’s satisfactions.

By benefiting views of these 30 knowledgeable persons, it was took action to recognize existing strategies for improving and boosting customer’s satisfactions by ANP method. For this reason, we used tables of priority determination, the mean of knowledgeable persons’ ideas, and determination of corresponding numbers with priorities for executing ANP model in the software. Then, by using Delphi technique, these 30 knowledgeable persons’ views were collected and assessed to identify organizationial infrastructures and its relevant sub-indexes. Finally, Friedman Test was used to determine the most important sub-indexes. The final survey model designed which is shown in figure 2. Hypotheses 3 and 4 are followed by this model.

Statistical society and survey sample quantity

In this survey, all of clients and consultants conclude the statistical society. Categorized sampling is used for survey sampling in this research. The formulas are as follows:

\[ n = \frac{N}{N + h} \]

\[ N = \frac{N}{N + h} \]

\[ N = \sum_{i=1}^{k} N_i \]

\[ N = \sum_{i=1}^{k} N_i + N_2 + N_3 + \ldots + N_k \]
In this survey, statistical society is determinate and data are qualitative, thus the below formula is used to find the sample quantity:

\[
\begin{align*}
\frac{ \gamma (\varepsilon)\sqrt{(1-p)}\sqrt{p(1-p)}}{\gamma (\varepsilon)\sqrt{(1-p)}\sqrt{p(1-p)}}
\end{align*}
\]

\(n\): Sample quantity  
\(N\): Statistic society quantity  
\(p\): Statistic society successful ratio  
\(1-p\): Statistic society unsuccessful ratio  
\(\varepsilon\): Estimation1 accuracy ratio  
\(Z\): Normal variable ratio in relation to assurance area (1-\(\alpha\))

In this research assurance area is considered as 95% therefore:

\[
\alpha=5%\quad (5.1.5)
\]

\[
Z_{\alpha/2}=1.96\quad (5.1.6)
\]

Considering this fact which the most researches in management field are qualitative, amount of p is very important and if there was not a good estimation of successful ration in surveys, researches are allowed to assume 50% for p, thus:

\[
p=0.5\quad (5.1.7)
\]

Also in researches, \(\varepsilon\) which is estimation accuracy ratio is between 0.01 and 0.1. In this survey the amount of \(\varepsilon\) is considered as 0.1, thus:

\[
\varepsilon=0.1\quad (5.1.8)
\]

Statistical society in this survey is known, thus N is defined.

\[
N=371\quad (5.1.9)
\]

Thus:

\[
\gamma (\varepsilon)=\frac{\gamma (\varepsilon)(1-p)\sqrt{p(1-p)}}{\gamma (\varepsilon)(1-p)\sqrt{p(1-p)}}=\gamma (\varepsilon)\sqrt{(1-p)}\sqrt{p(1-p)}=\gamma (\varepsilon)\sqrt{(1-p)}\sqrt{p(1-p)}
\]

Sampling number is calculated as 76 and to reach that, the researcher produced 20% extra number for questionnaires, thus, the total number of questionnaires is 91.

In table 5.1, statistical society and statistical sampling are shown according to client and consultant (Ferma company’s customer) organization level.

See Table 5.1.

Validity and Reliability

Researcher reached to validity of the questionnaire while the expert persons confirmed it. Also to check the reliability of questionnaire, Kronbach Alpha method is used. If Kronbach Alpha which is calculated by SPSS software is more than 0.7, the questionnaire is reliable. In this research \(\alpha = 0.937\), show that the questionnaire has enough reliability.

Results

First question and hypothesis of survey:

- What is the most important area of project management that can have the greatest impact on scope of customer’s satisfactions if IT is applied in BRP of PBOs?
- Cost as the area of project management has the most important effect on customer’s satisfaction in case of using IT in BRP of PBOs.

\[
H_0: \mu_1=\mu_2=\ldots=\mu_{n}\quad (6.1.1)
\]

\[
H_1: \mu_1\neq\mu_2\neq\ldots\neq\mu_{n}\quad (6.1.2)
\]

Friedman test was applied to evaluate the trueness of first hypothesis.

See tables 6.1.1 and 6.1.2.

Based on table:

\[
\chi^2_{0.05}=5.991\quad (6.1.3)
\]

Thus:

\[
\begin{align*}
48.604 &> 5.991 \quad (6.1.4) \\
0.000 &< 0.25 \quad (6.1.5)
\end{align*}
\]

Therefore:

\[
\mu_1\neq\mu_2\neq\ldots\neq\mu_{n}\quad (6.1.6)
\]

Obtained results show that cost is the most important factor in scope of customer’s satisfactions with 2.59 ranking mean. Also the other areas are in following ranking. Respectively, time with 1.78 ranking mean, quality with 1.73 ranking mean, communication with 1.65 ranking mean, risk with 1.53 ranking mean, human resource with 1.52 ranking mean, procurement with 1.45 ranking mean, scope with 1.43 ranking mean and finally integration with 1.39 ranking mean are the later areas which are influencing to customer’s satisfactions.

Delphi technique also demonstrates that aspects of cost, time and quality from the viewpoint of knowledgeable persons have the greatest effect on customer’s satisfactions. Also, repetitive BRP, Value Engineering, knowledge management and change management are main strategies for improving areas of project management. Determination and identification of IT infrastructures and structural infrastructures are among the other views which said 30 knowledgeable persons expressed. Based on this result, the model of survey summarized to figure 2 according to this explanation.

See Fig. 6.1.

**Fig. 6.1:** Analytical model of survey in phase 1.

Result: Cost as the area of project management has the most important effect on customer’s satisfaction in case of using IT in BRP of PBOs.

Second question and hypothesis of survey

- What is the most important strategy or solution for improving customer’s satisfactions in PBOs?
- BRP is the most important strategy for improving customer’s satisfactions in PBOs.

ANP method was applied to evaluate trueness of second hypothesis of survey.

See figure 6.2.

**Fig. 6.2:** Model of survey at Super Decision software (a). Output result for priorities of strategies (b).

See table 6.2.
According to incoherence coefficient = 0.0539, which is less than 0.1, it was concluded that BRP which is 62%, is the most suitable solution/strategy for improving customer’s satisfactions (was determined by knowledgeable persons) in PBO’s. The other strategies respectively are in following ranking as value engineering with 22% of ranking mean, knowledge management with 22% of ranking mean and finally change management with 5% of ranking mean.

Result: BRP is the most important strategy for improving customer’s satisfactions in PBOs.

**Third question and hypothesis of survey**

- What is the most important sub-index of structural infrastructures for BRP of PBOs?
- IT is the most important sub-index of structural infrastructures for BRP of PBOs.

\[
\begin{align*}
H_0 : & \mu_1 = \mu_2 = \ldots = \mu_n \\
H_1 : & \mu_1 \neq \mu_2 \neq \ldots \neq \mu_n
\end{align*}
\]

\[\text{Friedman Test was used to evaluate the trueness of third hypothesis.}
\]

See figure 6.3.1 and 6.3.2. Based on table:

\[\chi^2_{0.05} = 16.919\] (6.4.3)

Thus:

\[
\begin{align*}
160.548 & > 16.919 \\
0.000 & < 0.25
\end{align*}
\]

Therefore:

\[\mu_1 \neq \mu_2 \neq \ldots \neq \mu_n\] (6.4.6)

Obtained results show that among components of six-fold infrastructures of structural, IT component with mean rank of 7.48 is the most influencing factor on customer’s satisfactions. Also the other sub-indexes are in following ranking. Respectively, Governance with 5.05 ranking mean, Strategy with 4.89 ranking mean, Leadership with 4.84 ranking mean, Culture with 4.68 ranking mean and finally Specialty with 4.66 ranking mean are the later sub-indexes of IT infrastructure which are influencing to customer’s satisfactions.

Result: IT is the most important structural infrastructure in BRP of PBOs.

**Fourth question and hypothesis of survey**

- What is the most important sub-index of IT infrastructures for BRP of PBOs?
- Software is the most important sub-index of IT infrastructures for BRP of PBOs.

\[
\begin{align*}
H_0 : & \mu_1 = \mu_2 = \ldots = \mu_n \\
H_1 : & \mu_1 \neq \mu_2 \neq \ldots \neq \mu_n
\end{align*}
\]

Friedman Test was applied to evaluate the trueness of third hypothesis. See figure 6.4.1 and 6.4.2. Based on table:

\[\chi^2_{0.05} = 16.919\] (6.3.3)

Thus:

\[
\begin{align*}
160.548 & > 16.919 \\
0.000 & < 0.25
\end{align*}
\]

Therefore:

\[\mu_1 \neq \mu_2 \neq \ldots \neq \mu_n\] (6.3.6)

Obtained results show that among components of four-fold infrastructures of IT, software component with mean rank of 8.30 is the most influencing factor on customer’s satisfactions. Also the other sub-indexes are in following ranking. Respectively, hardware with 5.66 ranking mean, automation with 4.93 ranking mean and finally e-sale with 4.49 ranking mean are the later sub-indexes of IT infrastructure which are influencing to customer’s satisfactions.

Result: Software is the most important infrastructure of IT in BRP of PBOs.

**Conclusion and Discussion**

In this survey, a group of crystallized speeches from studying fundamentals of components identifications, IT and also structural infrastructure were questioned by its customers in the trend of BRP of PBOs to evaluate scope of effect on customer’s satisfactions.

According to the fact that the main issue in this survey is the evaluation of role and effect of IT on customer’s satisfactions in PBOs with trend of BRP (in Ferma Co.), the following results were obtained in this survey:

- Cost as the area of project management has the most important effect on customer’s satisfaction in case of using IT in BRP of PBOs.
- BRP is the most important strategy for improving customer’s satisfactions in PBOs.
- IT is the most important structural infrastructure in BRP of PBOs.
- Software is the most important infrastructure of IT in BRP of PBOs software.
- Based upon conducted analyses about obtained results from sent questionnaire to some customers of Ferma Co.’s customers, there was no evidence rejecting above-mentioned hypotheses.

In all levels of conducting BRP of PBOs, strengthening an IT different departments of an organization and using appropriate software such as financial, purchase, warehouse, design software and … for decision making, giving report and … have a paramount importance. It is essential for PBOs to revise and re-plan work processes so that it will have full conformity with all levels of project execution; and costs that the organization will incur via this way will be decreased in first instance and quality of services will be boosted and time of project execution will be shortened in second instance.

In regard to increasing market growth, need for energy and requirement for more strengthening of PBOs for faster and more dynamic survival, there is a favourable vision about BRP of organizations by their managers. Directors/leaders of organizations totally consider this method effective and positive in the scope of IT effect on set of BRP of project management processes through effective training.

Findings of these surveys can play an important role in recognizing weak and strength points of organizations and similar companies that have affinity and similarity in type of work or activity. Therefore, following suggestions can be offered:

- Doing similar survey in other PBOs such as consulting companies and contractors.
- Doing similar survey in relation with internal customers of companies.
- Correlative study of applied IT in BRP of domestic companies in comparison with foreign organizations.

**References**


Table 5.1: statistical society and statistical sampling according to client and consultant organization level

<table>
<thead>
<tr>
<th>Organization</th>
<th>Organization level</th>
<th>Statistical society</th>
<th>%</th>
<th>Statistical sampling</th>
<th>Chosen sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Project manager</td>
<td>153</td>
<td>41</td>
<td>31</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Project executor</td>
<td>51</td>
<td>14</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Consultant</td>
<td>Project manager</td>
<td>132</td>
<td>36</td>
<td>27</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Project executor</td>
<td>35</td>
<td>9</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>371</td>
<td>100</td>
<td>76</td>
<td>91</td>
</tr>
</tbody>
</table>

Table 6.1.1: Descriptive Statistics of project management area.

<table>
<thead>
<tr>
<th>Area</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration</td>
<td>91</td>
<td>3.0003</td>
<td>0.70532</td>
<td>1.41</td>
<td>4.21</td>
</tr>
<tr>
<td>Scope</td>
<td>91</td>
<td>3.1388</td>
<td>0.72334</td>
<td>1.49</td>
<td>4.31</td>
</tr>
<tr>
<td>Time</td>
<td>91</td>
<td>3.5388</td>
<td>0.61174</td>
<td>1.75</td>
<td>4.56</td>
</tr>
<tr>
<td>Cost</td>
<td>91</td>
<td>4.0403</td>
<td>0.50556</td>
<td>1.61</td>
<td>4.81</td>
</tr>
<tr>
<td>Quality</td>
<td>91</td>
<td>3.5659</td>
<td>0.69783</td>
<td>1.33</td>
<td>4.54</td>
</tr>
<tr>
<td>Human resource</td>
<td>91</td>
<td>3.0342</td>
<td>0.69564</td>
<td>1.43</td>
<td>4.69</td>
</tr>
<tr>
<td>Communication</td>
<td>91</td>
<td>3.1328</td>
<td>0.63213</td>
<td>1.64</td>
<td>4.25</td>
</tr>
<tr>
<td>Risk</td>
<td>91</td>
<td>3.2864</td>
<td>0.64653</td>
<td>1.52</td>
<td>4.32</td>
</tr>
</tbody>
</table>

Table 6.1.2: Ranking mean of project management area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Integration</th>
<th>Scope</th>
<th>Time</th>
<th>Cost</th>
<th>Quality</th>
<th>Human resource</th>
<th>Communication</th>
<th>Risk</th>
<th>Procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking mean</td>
<td>1.39</td>
<td>1.43</td>
<td>1.78</td>
<td>2.59</td>
<td>1.73</td>
<td>1.52</td>
<td>1.65</td>
<td>1.53</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Test Statistics<sup>a</sup>

<table>
<thead>
<tr>
<th>Test Statistics&lt;sup&gt;a&lt;/sup&gt;</th>
<th>N</th>
<th>Chi-square</th>
<th>Df</th>
<th>Asymp. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>91</td>
<td>48.604</td>
<td>2</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 6.2: Ranking mean of strategies for improving customer’s satisfactions.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Change Mgmt.</th>
<th>Knowledge Mgmt.</th>
<th>Value Engineering</th>
<th>BRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking mean</td>
<td>0.053461</td>
<td>0.107152</td>
<td>0.219547</td>
<td>0.619840</td>
</tr>
</tbody>
</table>

Table 6.3.1: Descriptive Statistics of six-fold structural infrastructure.

<table>
<thead>
<tr>
<th>Sub-indexes</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture</td>
<td>91</td>
<td>3.5714</td>
<td>.68949</td>
<td>1.25</td>
<td>4.75</td>
</tr>
<tr>
<td>IT</td>
<td>91</td>
<td>4.1978</td>
<td>.72984</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Leadership</td>
<td>91</td>
<td>3.5467</td>
<td>.67073</td>
<td>1.50</td>
<td>4.75</td>
</tr>
<tr>
<td>Governance</td>
<td>91</td>
<td>3.5971</td>
<td>.77383</td>
<td>1.67</td>
<td>4.67</td>
</tr>
<tr>
<td>Strategy</td>
<td>91</td>
<td>3.5385</td>
<td>.80396</td>
<td>1.33</td>
<td>4.67</td>
</tr>
<tr>
<td>Specialty</td>
<td>91</td>
<td>3.4505</td>
<td>.97768</td>
<td>1.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>
Table 6.3.2: Ranking mean of six-fold structural infrastructure

<table>
<thead>
<tr>
<th>Sub-indexes</th>
<th>Culture</th>
<th>IT</th>
<th>Leadership</th>
<th>Governance</th>
<th>Strategy</th>
<th>Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking Means</td>
<td>4.68</td>
<td>7.48</td>
<td>4.84</td>
<td>5.05</td>
<td>4.89</td>
<td>4.66</td>
</tr>
</tbody>
</table>

Test Statistics

| N | 91 |
| Chi-square | 160.548 |
| df | 9 |
| Asymp. Sig. | .000 |

Table 6.4.1: Descriptive Statistics of four-fold IT infrastructure.

<table>
<thead>
<tr>
<th>Sub-index</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software</td>
<td>91</td>
<td>4.3516</td>
<td>.63705</td>
<td>1.33</td>
<td>5.00</td>
</tr>
<tr>
<td>e-sale</td>
<td>91</td>
<td>3.4725</td>
<td>.87357</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Hardware</td>
<td>91</td>
<td>3.7308</td>
<td>.87340</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Automation</td>
<td>91</td>
<td>3.5440</td>
<td>.95931</td>
<td>1.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Table 6.4.2: Ranking mean of four-fold IT infrastructure.

<table>
<thead>
<tr>
<th>Sub-indexes</th>
<th>Software</th>
<th>e-sale</th>
<th>Hardware</th>
<th>Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking mean</td>
<td>8.30</td>
<td>4.49</td>
<td>5.66</td>
<td>4.93</td>
</tr>
</tbody>
</table>

Test Statistics

| N | 91 |
| Chi-square | 160.548 |
| df | 9 |
| Asymp. Sig. | .000 |

a. Friedman Test