

Digitalizing 360 Degree Employee Competency using Banzhaf Power Index and CDF

J. Mahalakshmi, K. Umadevi

Abstract: Traditionally, 360 degree evaluation of employee competency has been done using ratings given by Subordinates or Direct Reports, Peers, Manager and Self. Based on the rating by all rating group, the competency of the employee is determined. The gap between self-rating and ratings of all other group determines whether an employee has hidden strength or has blind spot in each competency variable. However, whenever larger number of subordinates or peers rates an employee, there is inherent bias and the employee's overall competency rating can be low if the larger group holds grudge against the employee. To avoid bias and determine true rating, this paper proposes innovative use of Banzhaf Power Index. The complete computation and digitalization of Banzhaf Power Index for Chennai based Wind Energy Company is carried out and presented in this paper. The interactive Wolfram Computable Document Format (CDF) has also been created for wider use by personnel managers of other companies.

Keywords : 360 degree evaluation, Employee Competency, Banzhaf Power Index, Wolfram Computable Document Format.

I. INTRODUCTION

One of the popular and elaborate method of rating an employee's competency is 360 degree evaluation. In this method, the Subordinates (Direct Reports), Peers and Manager rates an employee's competency on a 5 point scale. The employee also rates himself on his competencies. The overall rating of the group determines the final competency score of the employee. However, this method is riddled with many problems, the chief among them being group bias. Whenever large numbers of subordinates or peers rate an employee, there is inherent bias and the employee's overall competency rating becomes low if the larger rating group holds grudge against the employee. In order to overcome this bias and compute true rating, Banzhaf Power Index can be modified to suit the 360 degree evaluation.

The Banzhaf power index or Penrose - Banzhaf index was invented by John F. Banzhaf. It is computed by the probability of changing the outcome of a vote where ever the voting rights are not equally divided among the voters or raters. The Banzhaf power index is only applied for larger rating groups like subordinates and peers since group bias – as against individual bias- can stem only from these raters.

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This method is applied to competency ratings of 50 employees of Chennai based wind Energy Company. In order to compute the Banzhaf power index and digitalize the entire process, interactive Wolfram Computable Document Format (CDF) has also been created.

II. REVIEW OF LITERATURE

The key research literature pertaining to competency mapping and Banzhaf power index which were examined are delineated below :

P. Suguna, T. Tamil Selvi (2013) examined employee Competency Mapping in garment firms in Tirupur district. This study gives concise summary of competency measurements in garment firms and gives a good view of method used to determine competencies in traditional garment manufacturing companies.

S. Balaji & D. Vimala (2012) carried out Competency Mapping in Adecco Service Organizations, Chennai Asia Pacific and their study elaborates the traditional competency mapping methods in a typical service company.

Su-Chin Hsieh Jui-Shin Lin Hung-Chun Lee (2012) reviewed a large body of international research literature on competency ratings. The meta review gives a very good insight into the practice of competency mapping among international companies.

Y. Nagaraju and V. Sathyanarayana Gowda (2012) examine the strategies of competency mapping in Bangalore companies and contrast the various strategies used.

The Banzhaf related literature which were studied and reviewed includes

B. Llamazares (2006) research focused mathematics of on how difference of votes determines majority.

Matsui, Tomomi and Matsui, Yasuko (2000) reviewed the various algorithms for Calculating Power Indices of Weighted Majority Games which form basis of applying Banzhaf power index to various business situations.

Lehrer, Ehud (1988) in his paper on axiomatization of the Banzhaf Value shows the method of axiomatization using three axioms. None of the papers adopted the Banzhaf power index to evaluate the employee competency which is the reason this paper used Banzhaf power index in an innovative way to remove group rating bias.

III. OBJECTIVES OF THE STUDY

The main objectives of this study are:

- Determine senior employees 360 degree



competency ratings for Building Team, Motivating Others, Accountability, Coaching, Communication, Collaborative Leadership, Conflict Management and Service

- Examine if the senior employees competencies show Blind Spot and Hidden Strength
- Compute Banzhaf Power Index for group of 6 rater groups (3 Subordinates and 3 Peer raters for each of the 50 employees)
- To create an interactive Banzhaf Power Index Computable Document Format (CDF) for wider use by personnel managers.

IV. RESEARCH METHODOLOGY

A. Research Design

This is a descriptive study investigating the competencies of senior employees in Chennai based wind Energy Company.

B. Sample and Sampling Method

Out of total 62 senior employees in the wind energy company, 50 employees were selected using random sampling method. The employees who had 5 to 10 years' experience in renewable energy industry were considered to be senior employees. The competency rating on 5 point scale for selected 50 employees was obtained from randomly assigned group of 3 Subordinates (Direct Reports), group of 3 Peers and 1 Manager. Each senior employees' self-rating too was obtained. The ratings were obtained on standard company 360 degree rating form.

C. Area of Study

Wind Energy Company in Chennai, Tamilnadu, India.

D. Data Collection

360 degree standard 5 point company rating form was used for data collection.

V. DATA ANALYSIS

The various methods used for data analysis is described below:

- **Competency Rating:** The competency rating was given on a 5 point scale. The average rating given by group of 3 Subordinates (Direct Reports), group of 3 Peers and 1 Manager for each of the 50 senior employee was determined and each variables competency score was determined. The Competency variables and their descriptions are given below:

Table - 1: Competency variables and their description

Competency Variable	Description of the Competency variable
Building Team	Is the employee able to create productive and efficient workgroups?

Motivating Others	Is the employee creating and sustaining work culture that encourages subordinates and peers do their best ?
Accountability	Is the employee taking responsibility for his/ her performance and work results?
Coaching	Is the employee mentoring others to develop better team capabilities ?
Communication	Is the employee able to relay and receive official communication effectively?
Collaborative Leadership	Is the employee seeking cooperation and feedback from his peers in decision making process?
Conflict Management	Is the employee able to resolve disagreements effectively?
Service	Is the employee dedication to meet needs of organizations customers and stack holders?

Blind Spot: Competencies where self-raters perception are greater than the other raters are called blind spots. This shows the weakness of the employee. It is derived from the difference between the average rating of all groups and self-rating of the employee.

Hidden Strengths: Competencies where other raters perceptions of performance are greater than the self-raters. This shows the strength of the employee which he/she is unaware of. It too is derived from the difference between the average rating of all groups and self-rating of the employee.

Banzhaf Power Index: It is determined by the formula

$$\text{Banzhaf Power Index } B_i = \frac{c_i}{\sum_{k=1}^n c_k}$$

Where c_i = Number of times rater i is critical

$\sum_{k=1}^n c_k$ = Sum of times when all raters are critical

VI. ANALYSIS AND INTERPRETATION

Competency Analysis

The Competency rating of all 50 senior employees was collated and average was computed based on 400 data points (50 x 3 Subordinates / Direct Reports, group of 3 Peers x 50, 50 x 1 Manager and 50 x 1 self-rating) .

The results are presented in the following table

Table - 2: Comprehensive Competency Rating

Rating	Direct Reports	Peers	Manager	Self	All Raters	Perception
Overall Rating	3.5	3.5	3.6	3.6	3.53	Blind Spot
Building Team	3.5	3.4	3.5	3.6	3.47	Blind Spot
Motivating Others	3.5	3.5	3.6	3.6	3.53	Blind Spot
Accountability	3.6	3.5	3.5	3.7	3.53	Blind Spot
Coaching	3.5	3.4	3.5	3.6	3.47	Blind Spot
Communication	3.6	3.5	3.5	3.7	3.53	Blind Spot
Collaborative Leadership	3.5	3.5	3.6	3.6	3.53	Blind Spot
Conflict Management	3.4	3.4	3.6	3.7	3.47	Blind Spot
Service	3.5	3.5	3.6	3.3	3.53	Hidden Strengths

From the above table it can be inferred noted that the average Over All competency rating of senior employees is 3.53. Over all, senior employees suffer from Blind spot which indicates that their self-rating of most competency variable is higher than the group rating.

The Building Team competency rating of senior employees is 3.47. Senior employees suffer from Blind spot in this variable too. It indicates that their self-rating of competency variable is higher than the group rating.

In Motivating others, competency rating of senior employees is 3.53. Here too the senior employees suffer from Blind spot. It indicates that their self-rating of this competency variable is higher than the group rating.

In case of Accountability, competency rating of senior employees is 3.53. Here too the senior employees suffer from Blind spot. It indicates that their self-rating of this competency variable is higher than the group rating.

When it comes to coaching, competency rating of senior employees is 3.47. Here too the senior employees suffer from Blind spot. It indicates that their self-rating of this competency variable is higher than the group rating.

As far as Communication is concerned, competency rating of senior employees is 3.53. The senior employees suffer from Blind spot in this competency too. It indicates that their self-rating of this competency variable is higher than the group rating.

Rating of Collaborative Leadership indicates that competency rating of senior employees is 3.53. The senior employees suffer from Blind spot in this competency too. It indicates that their self-rating of this competency variable is higher than the group rating.

Conflict Management rating indicates that competency rating of senior employees is 3.47. The senior employees suffer from Blind spot in this competency too. It indicates that their self-rating of this competency variable is higher than the group rating.

Service is the only competency which indicates hidden strength of the senior employees with rating of 3.53. It indicates that their self-rating of this competency variable is lower than the group rating. Hence they perceive themselves to be less competence than what other rates perception.

Competency Gap Analysis:

The competency gap analysis of the senior employees are depicted in the radar chart below. The radar chart comprehensively depicts the difference in self and other group ratings.

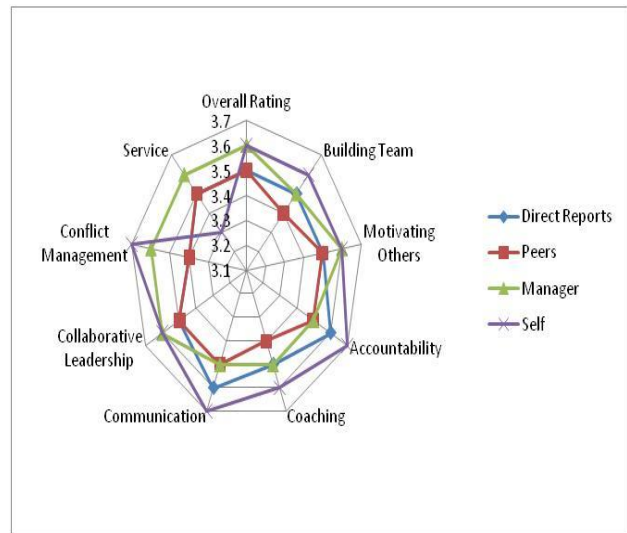


Figure - 1: Comprehensive Competency Rating Gap Analysis

It can be noted from the above figure that Self rating is higher than all other rating for all competency variables except Service competency variable. Peers have given lower rating in most of the competency variables than other groups. The Radar chart clearly shows that the employees have to strive hard to overcome the lower perception on competencies as determined by their Subordinates, peers and managers.

Banzhaf Power Index Analysis:

The Banzhaf Power index is computed based on group of 3 subordinate rating and group of 3 peer ratings. In order to compute the Banzhaf Power Index and digitalize the process, an interactive Computable Document Format was created with Wolfram Mathematica Version 11.0 by the authors based on Seth J. Chandler’s code.



In order to remove the group bias in the competency ratings, Banzhaf Power Index is calculated. The percentage needed to declare competency is set at 0.508 and raw rating is set same for all the raters. With the aforementioned settings,

the computed Banzhaf Power Index is shown below.

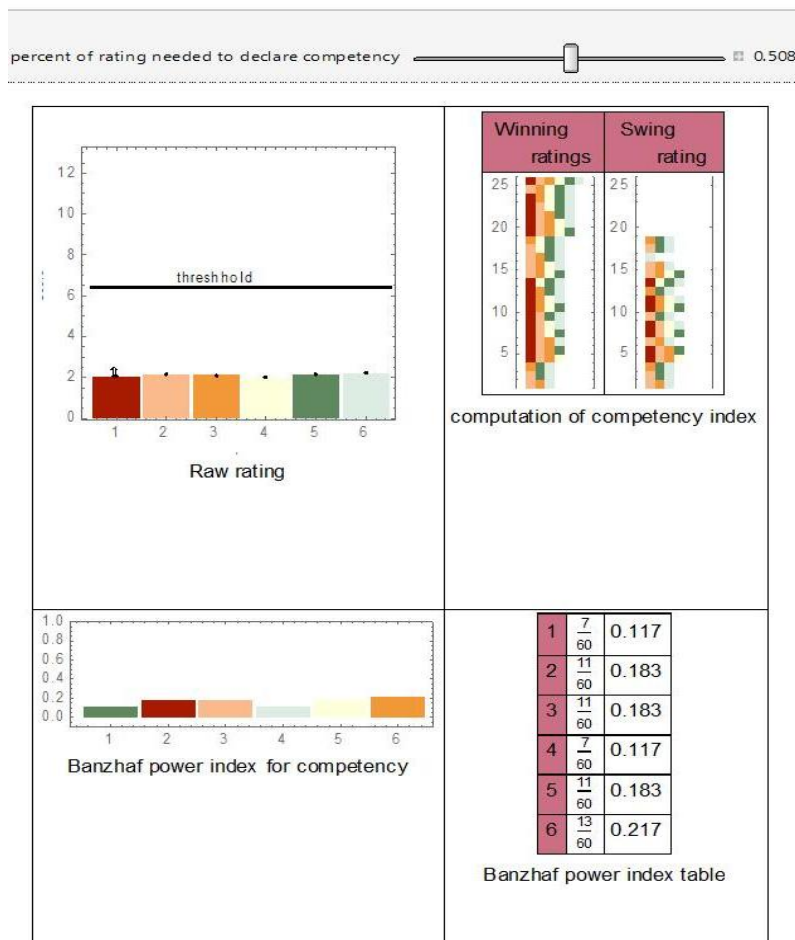


Figure - 2: Banzhaf Power Index for Equal Raw Rating

The Banzhaf Power Index for aforementioned setting is tabulated below:

Table 3: Banzhaf Power Index for Equal Raw Rating

Raters	Raw Rating	Banzhaf Power Index
Subordinate1	2	0.117
Subordinate2	2	0.183
Subordinate3	2	0.183
Peers1	2	0.117
Peers2	2	0.183
Peers3	2	0.217

It can be inferred from the above table that Subordinate 1 and Peers1 have the lowest Banzhaf Power Index of 0.117 hence ratings of these two can be included in the Competency Rating to remove Group bias.

Similarly, if the percentage needed to declare competency is set at 0.508 and raw rating is set at 6 for 1st Subordinate and 7 for 2nd Subordinate, and 1 for all the raters computed Banzhaf Power Index changes. The results are tabulated below:

Table 4: Banzhaf Power Index for Unequal Raw Rating

Raters	Raw Rating	Banzhaf Power Index
Subordinate1	6	0.2
Subordinate2	7	0.44
Subordinate3	1	0.12
Peers1	1	0.12
Peers2	1	0.12
Peers3	1	0

It can be noted from the above table that Subordinate 3 and Peers1 and 2 have the lowest Banzhaf Power Index of 0.12 hence ratings of these three can be included in the Competency Rating to remove Group bias. It should be noted that Peer 3 has zero Banzhaf Power index and can be ignore for modified Competency rating.

The complete statistics of Banzhaf Power Index with Winning Rating, Swing rating, Banzhaf Power Index table and chart is depicted below in Figure 3.

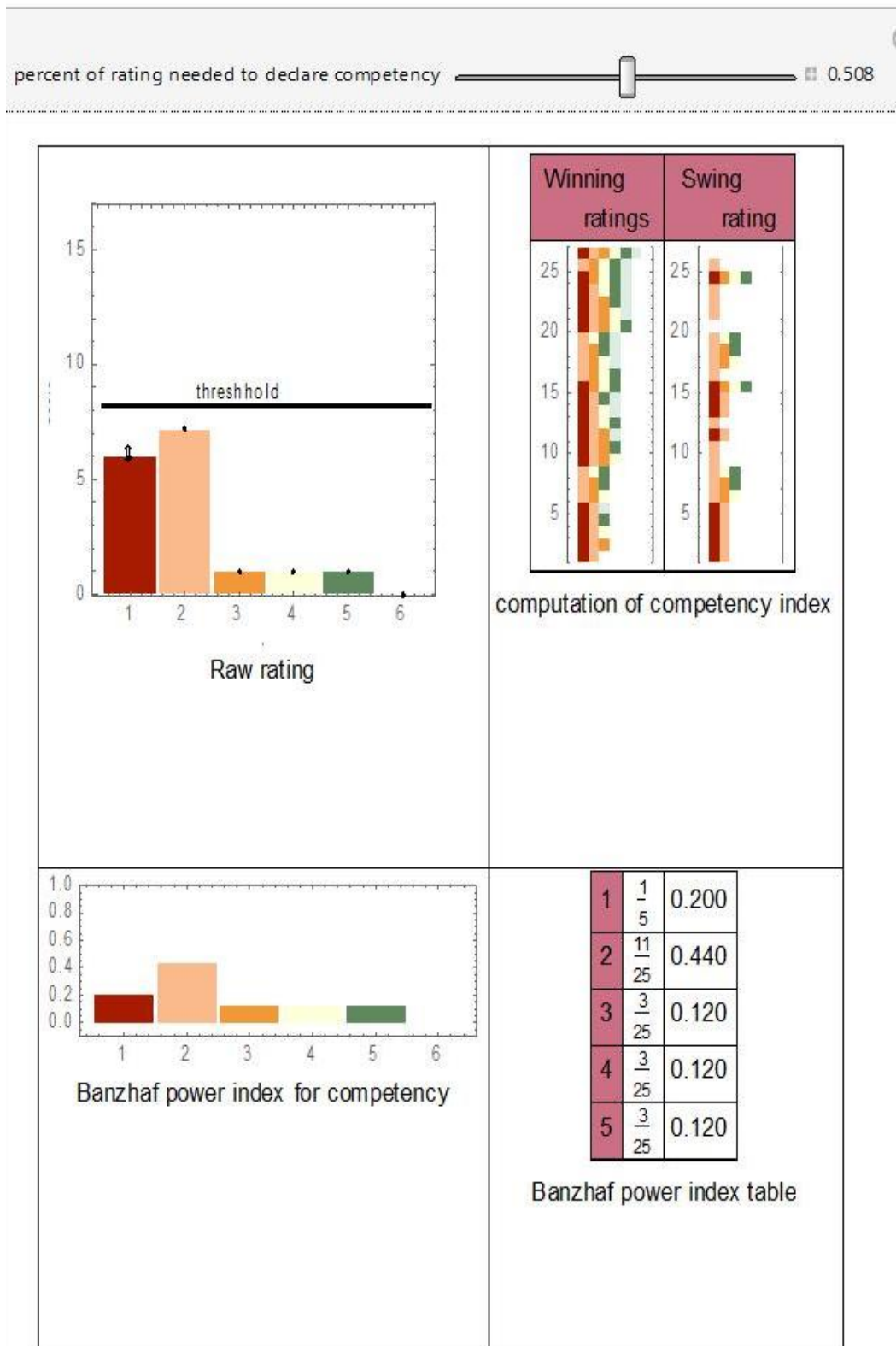


Figure 3: Banzhaf Power Index for Unequal Raw Rating

The computation of Banzhaf Power index has thus been digitalized for easy Competency rating without bias. Any value of raw rating can be assigned and computation can be carried out.

To make the entire Banzhaf Power Index general and digitalized for use by Personnel manager, interactive Banzhaf Power Index was created in computable document format by the authors.

Interactive Banzhaf Power Index Computable Document Format:

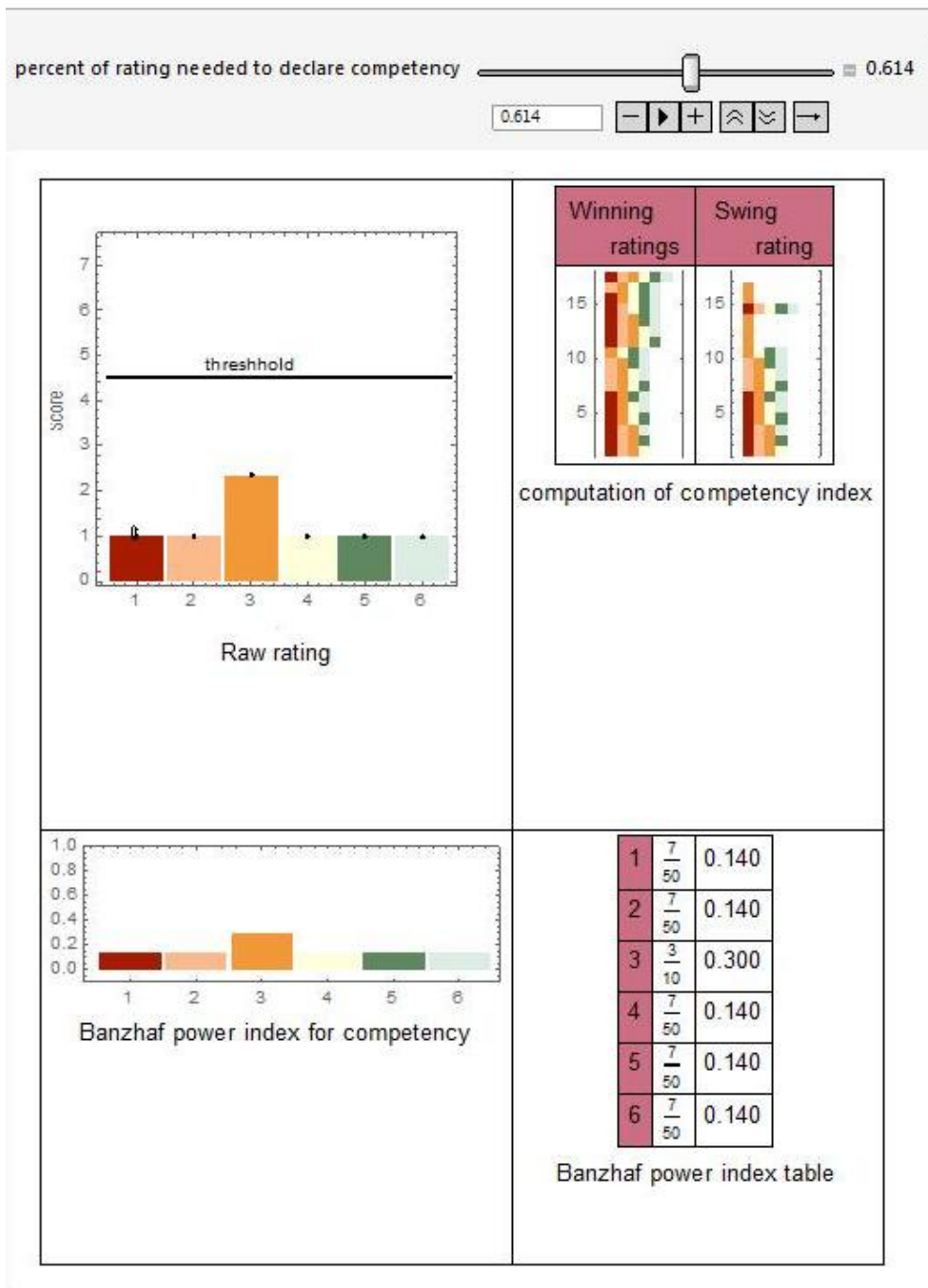


Figure 4: Screen Shot of Interactive Banzhaf Power Index

The features of interactive Banzhaf Power Index include

- Manipulate Percentage of rating needed to declare competency using slider range from 0 to 1
- Manipulate each of the 6 Raw rating using bar chart handles
- Auto computation of Banzhaf Power index chart and Index.

VII. FINDINGS

The major findings of the study are summarized below

- Over All competency rating of senior employees is 3.53. Over all, senior employees suffer from Blind spot which indicates that their self-rating of most competency

variable is higher than the group rating.

- Service is the only competency which indicates hidden strength of the senior employees with rating of 3.53. It indicates that their self-rating of this competency variable is lower than the group rating. They perceive themselves to be less competence than what other rates perception.
- Gap Analysis too indicates that that Self rating is higher than all other rating for all competency variables except Service competency variable. Peers have given lower rating in most of the competency variables than other groups. Employees have to strive hard to overcome the lower perception on

competencies as determined by their Subordinates, peers and managers.

- When the percentage needed to declare competency is set at 0.508 and raw rating is set same for all the raters, Subordinate 1 and Peers1 have the lowest Banzhaf Power Index of 0.117 .
- When percentage needed to declare competency is set at 0.508 and raw rating is set at 6 for 1st Subordinate and 7 for 2nd Subordinate, and 1 for all the raters computed Banzhaf Power Index changes, Subordinate 3 and Peers1 and 2 have the lowest Banzhaf Power Index of 0.12.
- The computation of Banzhaf Power index works with digitalized interactive CDF for easy Competency rating without bias. Any value of raw rating can be assigned and computation can be carried out.

VIII. CONCLUSION

The major problem of group bias in 360 degree competency rating was comprehensively neutralized by innovative use of Banzhaf Power Index. The complete computation and digitalization of Banzhaf Power Index for Chennai based Wind Energy Company was carried out and presented in this paper. It can be concluded that the interactive Banzhaf Power Index Computable Document Format (CDF) has wide ranging uses in any rating where voter based bias can creep in. The methodology used in this paper can be generalized and can be applied across industry for rating employees. The ease of interactive computable document can lead to faster digitalization of the entire rating process. There is no doubt that an important tool for personnel managers for employee evaluation has been created and tested successfully by methodology used in this paper.

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APPENDIX

Banzhaf Power Index Code for Interactive CDF (based partially on Seth J. Chandler's code)

```
Manipulate[Module[{heights=Last/@{loc1,loc2,loc3,loc4,loc5,loc6},b,t},
t=Total[heights]*pct;
b=banzhafData[Range[Length[heights]],heights,t];
Grid[{{Labeled[Graphics[{MapIndexed[{ColorData[27][#2[[1]]],Rectangle[{#2[[1]]-0.47,0},{#2[[1]]+0.47,#}]&,heights]
,Thickness[0.01],Line[{{0.5,t},{Length[heights]+0.5,t}],Text["threshold",{Length[heights]/2,t},{0,-1}],AspectRatio->
1,Frame->True,FrameLabel->{"voter","Score"},PlotRange->{{0.3,Length[heights]+0.6},{-0.1,Total[heights]*1.05}},Image
eSize->250,ImagePadding->{{25,25},{25,25}}],Text@"Raw rating"],
Labeled[Text@Grid[{{"Winning ratings","Swing
rating"},{Graphics[MapIndexed[{ColorData[27][#],Rectangle[Reverse@#2]&,b[[1]],{2}],Frame->{False,True},PlotRang
e->{{0,8},{1,1+Length[b[[1]]}],Graphics[MapIndexed[{ColorData[27][#],Rectangle[Reverse@#2]&,b[[2]],{2}],Frame
->{False,True},PlotRange->{{0,8},{1,1+Length[b[[1]]}],Background->{None,{ColorData[27][0.5]}},Dividers->All,It
emSize->{6,1}],Text@"computation of competency
index"},{Labeled[Graphics[{MapIndexed[{ColorData[27][#2[[1]]],Rectangle[{#1[[1]]-0.47,0},{#1[[1]]+0.47,#1[[2]]}]&
,b[[3]]}],Frame->True,PlotRange->{{0.3,Length[heights]+0.6},{-0.1,1}},ImageSize->250,AspectRatio->1/3],Text@"Banz
haf power index for
competency"},Labeled[Text@Grid[Sort[Map[Append[#,NumberForm[N@#[[2]],{4,3}]&,b[[3]]],Dividers->All,Backgrou
nd->{{ColorData[27][0.3]},None}],Text@"Banzhaf power index
table"]}],Dividers->All,ItemSize->{Automatic,{30,20}},Alignment->{Center,Top}],{{pct,0.6666,"percent of rating
needed to declare
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{{loc5,{5,1}},{5,0},{5,10},Locator,Appearance->Graphics[Point[{0,0}]}]},
{{loc6,{6,1}},{6,0},{6,10},Locator,Appearance->Graphics[{Point[{0,0}]}]},TrackedSymbols->{loc1,loc2,loc3,loc4,loc5,l
oc6,pct},SaveDefinitions->True]
```

Interactive cdf Available at: <https://drive.google.com/open?id=1HfTmnZBN6mZXsBh7WhgTFYAhz616xIzw> (requires free cdf plugin from Mathematica)

