

## THE ROLE OF MANPOWER IN PROFITABILITY: A STATISTICAL ANALYSIS

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### ABSTRACT

**M**anpower strength of an it company is crucial to its health; this is proved by using regression analysis, data envelopment analysis and rank –sum test. Data from 23 different companies- both it and non-it companies and from india and the us has been collected and been analysed using the statistical techniques mentioned above and the hypothesis has been proved.

**Keywords:** manpower strength, profitability, linear regression analysis, correlation coefficient, data envelopment analysis, efficiency ratio, rank-sum test, wilcoxon-whitney- mann test.

While the paper on “the role of manpower in it companies” dealt with the above subject, the authors of that that paper dealt with proving the hypothesis stated above, it is necessary or us to understand and discuss the statistical methods adopted in that paper.<sup>1</sup>

While this adage appears to be true from general observations, its ramifications need to be explored and, most of all, need to be statistically proved from observations. Since the proposition stated above is stated as an aphorism, the precise meaning must come if the associated conditions – constraints in mathematical or statistical terms – are also considered. Accordingly it must be pointed out that this adage is varied to different degrees based on the nature of the organisation, the type of product or service it provides as well as the methods it adopts to produce its goods/services. Therefore, in the case of organisations -or ‘firms’ as specified by prof. Michael porter<sup>2</sup> – that are dependent on the heavy use of technology that is drastically being upgraded from time to time to enhance production and effectiveness, can be excluded this being the case, it is attempted to concentrate on the manpower strength in the information technology (it) organisation.

It may appear at first glance to be a bad choice since the information technology organisation is based on heavy use of technology. However, the it organisation by its very nature uses technology and in order to survive in a competitive world, they must use the latest available technology. Secondly, the technological changes in the it industry are unlikely to be drastic so that technological changes are less likely to cause severe changes in profitability. This distinction between the it organisation and the non-it organisation is necessary since one of the statistical procedures employed – the whitney, mann, wilcoxon (modified) rank-sum-test<sup>3</sup> – that is based on comparisons between two different populations.

In order to prove the hypothesis that “manpower strength of an organisation indicates its health”, it is first necessary to identify what constitutes ‘health’ of an organisation. Since the organisations being dealt with are all commercial organisations, profitability would appear to be the obvious choice for this. Secondly, it is necessary to define what constitute it and non-it companies. It companies are those companies whose prime activity consists of development, production, maintenance and marketing of hardware and software products. All other companies are classified as non-it companies. That being the case, annual data for profit and the manpower employed for that year needed to be collected and since data for both – it and non-it companies. Accordingly, data from some 23 companies from india and the us were collected from their published annual reports. These consisted of 10 it companies and 13 non-it companies. This was done for about 10 years for each company. The non-it companies selected were acc, icici, ranbaxy, siemens, state bank of india, steel authority of india, tata motors, tata steel, bank of america, boeing, pfizer, proctor & gamble and walmart, the it-companies selected were hcl, infosys, tcs, wipro, and apple. Cisco, dell, google, microsoft and oracle.

The analysis to test the hypothesis was done in three parts. In the first part, a simple linear regression analysis between manpower (as the  $x$  variable) and profit (as the  $y$  variable) was done. The correlation coefficients gave some significant information as the following table will indicate:

**TABLE 1**

| S. No.                     | Company Name             | R in PAT vs. Emp. Num |
|----------------------------|--------------------------|-----------------------|
| 1                          | ACC                      | 0.046                 |
| 2                          | ICICI                    | 0.979                 |
| 3                          | Ranbaxy                  | 0.164                 |
| 4                          | Siemens                  | 0.802                 |
| 5                          | State Bank of India      | 0.404                 |
| 6                          | Steel Authority of India | 0.821                 |
| 7                          | Tata Steel               | 0.978                 |
| 8                          | Tata Motors              | 0.813                 |
| 9                          | Bank of America          | 0.488                 |
| 10.                        | Boeing                   | 0.100                 |
| 11.                        | Pfizer                   | 0.156                 |
| 12.                        | Proctor & Gamble         | 0.840                 |
| 13.                        | Walmart                  | 0.892                 |
| <b>Average for Group 1</b> |                          | <b>0.576</b>          |
| 14.                        | HCL                      | 0.899                 |
| 15.                        | Infosys                  | 0.994                 |
| 16.                        | TCS                      | 0.997                 |
| 17.                        | WIPRO                    | 0.908                 |
| 18.                        | Apple                    | 0.959                 |
| 19.                        | CISCO                    | 0.752                 |
| 20.                        | DELL                     | 0.527                 |
| 21.                        | Google                   | 0.849                 |
| 22.                        | Microsoft                | 0.946                 |
| 23.                        | ORACLE                   | 0.984                 |
| <b>Average for Group 2</b> |                          | <b>0.882</b>          |

We can discuss the above table and draw the appropriate conclusions. It is obvious from the figures displayed in the above table that manpower plays an extremely important role in the profitability of it companies- worldwide and that its importance is less in “non it” companies. A glance at the correlation coefficient of 0.882 for it companies indicates the near linear dependence of profitability as the dependent variable (the y variable) on the manpower strength as the independent variable (the x variable). Compare this with the correlation coefficient of 0.576 for non-it companies. This indicates considerably less direct dependence of profitability on manpower strength.

We will now use data envelopment analysis<sup>4</sup> to find out whether the above conclusion is reinforced by applying the techniques suggested by data envelopment analysis. In order to do this, we consider the data for each company. For most companies, this data refers to annual manpower and profits for a period of ten years. Data for each company will be treated as one group. Data envelopment analysis is run for each company, the output one gets consists of the profitability/ efficiency ratio of 1 in case of the result in the most efficient year; the results for the other years are expressed as fractions of this efficiency standard. We can conclude tat if the average of this ratio for all years is high then it can be implied that manpower was effective over the entire period for which the data is analysed. In addition to this statistic, if we can compare this conclusion with that of the conclusions obtained from non it companies then the conclusions will be reinforced. This analysis has been performed and the details for each company are given below. The summary of the averages is given in table 2 whereas details of the radial environment analysis for most of the companies are given in subsequent tables.

**TABLE 2**

| S. No.                     | Company Name             | Efficiency (Average) | Ratio |
|----------------------------|--------------------------|----------------------|-------|
| 1                          | ACC                      | 0.469817             |       |
| 2                          | ICICI                    | 0.807520             |       |
| 3                          | Ranbaxy                  | 0.532475             |       |
| 4                          | Siemens                  | 0.425129             |       |
| 5                          | State Bank of India      | 0.540166             |       |
| 6                          | Steel Authority of India | 0.754213             |       |
| 7                          | Tata Steel               | 0.530452             |       |
| 8                          | Tata Motors              | 0.527256             |       |
| 9                          | Bank of America          | 0.644952             |       |
| 10.                        | Boeing                   | 0.532326             |       |
| 11.                        | Pfizer                   | 0.435432             |       |
| 12.                        | Proctor & Gamble         | 0.8080208            |       |
| 13.                        | Walmart                  | 0.4916495            |       |
| <b>Average for Group 1</b> |                          | <b>0.576889</b>      |       |
| 14.                        | HCL                      | 0.567965             |       |
| 15.                        | Infosys                  | 0.876757             |       |
| 16.                        | TCS                      | 0.972767             |       |
| 17.                        | WIPRO                    | 0.882089             |       |
| 18.                        | Apple                    | 0.405337             |       |
| 19.                        | CISCO                    | 0.768928             |       |
| 20.                        | DELL                     | 0.371925             |       |
| 21.                        | Google                   | 0.779934             |       |
| 22.                        | Microsoft                | 0.808021             |       |
| 23.                        | ORACLE                   | 0.918838             |       |
| <b>Average for Group 2</b> |                          | <b>0.735256</b>      |       |

The averages for the efficiency ratio that is the value of profit per unit of manpower, is certainly superior for it companies over a long term period (10 years) compared to non-it companies.

**ACC**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.081177 |
| 2                   | 2002 | 0.064659 |
| 3                   | 2003 | 0.124626 |
| 4                   | 2004 | 0.235503 |
| 5                   | 2005 | 0.381024 |
| 6                   | 2006 | 0.766675 |
| 7                   | 2007 | 0.895353 |
| 8                   | 2008 | 0.679337 |
| 9                   | 2009 | 1        |

**ICICI**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.600617 |
| 2                   | 2002 | 0.326646 |
| 3                   | 2003 | 0.963225 |
| 4                   | 2004 | 1        |
| 5                   | 2005 | 0.896692 |
| 6                   | 2006 | 0.929947 |
| 7                   | 2007 | 0.935511 |

**RANBAXY**

| Qry_Results_Weights |          |
|---------------------|----------|
| DMU                 | Score    |
| 2001                | 0.147099 |
| 2002                | 0.330196 |
| 2003                | 0.602023 |
| 2004                | 1        |
| 2005                | 0.568919 |
| 2006                | 0.228681 |
| 2007                | 0.372863 |
| 2008                | 0.582923 |
| 2010                | 0.479787 |

**SAIL**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2005 | 0.325676 |
| 2                   | 2006 | 0.918851 |
| 3                   | 2007 | 0.493868 |
| 4                   | 2008 | 0.797986 |
| 5                   | 2009 | 1        |
| 6                   | 2010 | 0.988897 |

**SIEMENS**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.141314 |
| 2                   | 2002 | 0.115608 |
| 3                   | 2003 | 0.292415 |
| 4                   | 2004 | 0.476353 |
| 5                   | 2005 | 0.254651 |
| 6                   | 2006 | 0.428568 |
| 7                   | 2007 | 0.413583 |
| 8                   | 2008 | 0.570934 |
| 9                   | 2009 | 0.567861 |
| 10                  | 2010 | 1        |

**TATA MOTORS**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2003 | 0.160767 |
| 2                   | 2004 | 0.413424 |
| 3                   | 2005 | 0.602389 |
| 4                   | 2006 | 0.744558 |
| 5                   | 2007 | 0.931847 |
| 6                   | 2008 | 0.945115 |
| 7                   | 2009 | 0.474463 |
| 8                   | 2010 | 1        |

**SBI**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.163571 |
| 2                   | 2002 | 0.253861 |
| 3                   | 2003 | 0.325721 |
| 4                   | 2004 | 0.38801  |
| 5                   | 2005 | 0.458161 |
| 6                   | 2006 | 0.485616 |
| 7                   | 2007 | 0.53562  |
| 8                   | 2008 | 0.820262 |
| 9                   | 2009 | 0.970838 |
| 10                  | 2010 | 1        |

**TATA STEEL**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.07264  |
| 2                   | 2002 | 0.029115 |
| 3                   | 2003 | 0.153878 |
| 4                   | 2004 | 0.271757 |
| 5                   | 2005 | 0.582258 |
| 6                   | 2006 | 0.603123 |
| 7                   | 2007 | 0.745868 |
| 8                   | 2008 | 0.875306 |
| 9                   | 2009 | 1        |
| 10                  | 2010 | 0.970214 |

**BANK OF AMERICA**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.540709 |
| 2                   | 2002 | 0.685904 |
| 3                   | 2003 | 0.855902 |
| 4                   | 2004 | 0.763921 |
| 5                   | 2005 | 0.8989   |
| 6                   | 2006 | 1        |
| 7                   | 2007 | 0.686742 |
| 8                   | 2008 | 0.158769 |
| 9                   | 2009 | 0.21272  |

**BOEING**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.290673 |
| 2                   | 2002 | 0.419364 |
| 3                   | 2003 | 0.49952  |
| 4                   | 2004 | 0.63921  |
| 5                   | 2005 | 0.785634 |
| 6                   | 2006 | 1        |
| 7                   | 2007 | 0.685352 |
| 8                   | 2008 | 0.180068 |
| 9                   | 2009 | 0.291116 |

**PFIZER**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.438551 |
| 2                   | 2002 | 0.471945 |
| 3                   | 2003 | 0.162425 |
| 4                   | 2004 | 0.500675 |
| 5                   | 2005 | 0.386555 |
| 6                   | 2006 | 1        |
| 7                   | 2007 | 0.476603 |
| 8                   | 2008 | 0.502092 |
| 9                   | 2009 | 0.375641 |
| 10                  | 2010 | 0.037836 |

**PROCTOR & GAMBLE**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.438551 |
| 2                   | 2002 | 0.471945 |
| 3                   | 2003 | 0.162425 |
| 4                   | 2004 | 0.500675 |
| 5                   | 2005 | 0.386555 |
| 6                   | 2006 | 1        |
| 7                   | 2007 | 0.476603 |
| 8                   | 2008 | 0.502092 |
| 9                   | 2009 | 0.375641 |
| 10                  | 2010 | 0.037836 |

**WALMART**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.683256 |
| 2                   | 2002 | 0.638824 |
| 3                   | 2003 | 0.2671   |
| 4                   | 2004 | 0.705032 |
| 5                   | 2005 | 0.442705 |
| 6                   | 2006 | 1        |
| 7                   | 2007 | 0.398995 |
| 8                   | 2008 | 0.359223 |
| 9                   | 2009 | 0.38276  |
| 10                  | 2010 | 0.0366   |

**CISCO**

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2002 | 0.351835 |
| 2                   | 2003 | 0.704129 |
| 3                   | 2004 | 0.86609  |
| 4                   | 2005 | 1        |
| 5                   | 2006 | 0.747822 |
| 6                   | 2007 | 0.835592 |
| 7                   | 2008 | 0.90794  |
| 8                   | 2009 | 0.626126 |
| 9                   | 2010 | 0.808902 |

## DELL

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.471969 |
| 2                   | 2002 | 0.42705  |
| 3                   | 2003 | 0.489404 |
| 4                   | 2004 | 0.223763 |
| 5                   | 2005 | 0.257263 |
| 6                   | 2006 | 0.307045 |
| 7                   | 2007 | 0.146054 |
| 8                   | 2008 | 0.170982 |
| 9                   | 2009 | 0.160717 |
| 10                  | 2010 | 1        |

## ORACLE

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 1        |
| 2                   | 2002 | 0.803948 |
| 3                   | 2003 | 0.861771 |
| 4                   | 2004 | 0.977244 |
| 5                   | 2005 | 0.878707 |
| 6                   | 2006 | 0.914601 |
| 7                   | 2007 | 0.870847 |
| 8                   | 2008 | 0.999007 |
| 9                   | 2009 | 0.991317 |
| 10                  | 2010 | 0.891082 |

## MICROSOFT

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2001 | 0.800901 |
| 2                   | 2002 | 0.531143 |
| 3                   | 2003 | 0.669791 |
| 4                   | 2004 | 0.697611 |
| 5                   | 2005 | 0.969619 |
| 6                   | 2006 | 0.842093 |
| 7                   | 2007 | 0.844636 |
| 8                   | 2008 | 0.942484 |
| 9                   | 2009 | 0.78193  |
| 10                  | 2010 | 1        |

## GOOGLE

| Qry_Results_Weights |      |          |
|---------------------|------|----------|
| NO                  | DMU  | Score    |
| 1                   | 2004 | 0.710703 |
| 2                   | 2005 | 0.928638 |
| 3                   | 2006 | 0.915506 |
| 4                   | 2007 | 0.760939 |
| 5                   | 2008 | 0.635841 |
| 6                   | 2009 | 1        |
| 7                   | 2010 | 0.507909 |

### Modified rank-sum test

This comparison further reinforced our earlier conclusion that there is an almost symbiotic link between manpower and profitability in information technology companies. However, there was one more test that could be carried out – the “wilcoxon-mann-whitney” test, also known as the “rank-sum-test”. In the third analysis wilcox-mann-whitney “rank-sum-test” (or a modification of this test) is performed between various companies (one from the “it group” verses one from the “non it group”). This comparison is carried out for several pairs of companies. The test that has been carried out is actually a slight modification of the test as propounded by its originators, but the results are extremely revealing. This comparison is carried out for several pairs of companies. This test checks the null hypothesis whether the two groups belong to the same population group or not. While this information may not be of great interest to us, the statistic suggested in this test will certainly point out the distinct dependence of profitability on manpower strength in it companies, in comparison to that in non it companies. In this test, we know that the data for each company belongs to the same population group; we are going to test the ranking of data. The modification to the test has been made for testing these rankings. The test is described below.

The rank-sum test also sometimes called the wilcoxon – mann – whitney test<sup>4</sup> is a statistical test based on ranking of data. Given independent data belonging to different groups, this test serves to test whether the hypothesis that the two groups belong to the same population or whether they differ significantly. This is done by taking the elements from both groups and arranging them in order of their value, then ranking them in order of their values. After this is done the ranking is identified from one onwards. Suppose group a consists of  $m$  elements, and group b consists of  $n$  elements then the mixed group will have  $m+n$  elements. These elements are then ranked from 1 to  $m+n$ , while keeping the identity of the group to which they belong, intact. Then the ranks from each group are summed. In case there is a tie (for example if there are two '1's, they are both replaced by 1.5 and the next rank number is not 2 but 3). Therefore, if the ranks from group a sum to  $sa$  and the ranks from group b sum to  $sb$ , then the statistics from group a is calculated in the following manner:

$$t = \frac{sa - mn(m+n+1)/2}{\sqrt{m+n+1)/12}}$$

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$$\sqrt{m+n+1)/12}}$$

Using this statistic, the level of significance is checked, since the distribution is assumed to be normal. The following modifications have been done to this test<sup>5</sup>.

Given the above analysis, the following argument has been made: assuming that both groups do belong to the same population, we can use the above method to check the rankings. For calculating the rankings of 2 groups, the above method is used. If  $m$  and  $n$  are both the same, that is, they are equal. With these restrictions, there is no need to normalise and the sums of the ranks, that is  $sa$  and  $sb$  can be calculated and directly compared. Then the figures  $sa$  and  $sb$  are compared for the ranking. This was done for several pairs of companies.

We can, therefore, safely say that the strategic importance of manpower in the information technology organisation has been adequately proved by studying the past performances of several information technology organisations; the study of the relationships between their manpower and profitability by regression analysis and the comparison of their efficiency/effectiveness ratios with that of those for non information technology companies. The conclusion that can be safely drawn from the live use of these statistical methods is that wilcoxon – mann - whiney whitney test can be safely used.

It is time now to cogitate over what lessons can be learnt by information technology companies, from this analysis.



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