

Aviskaar

A Xaverian Journal of Research

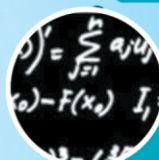


St. Xavier's College
(Autonomous)

30 Mother Teresa Sarani (Park Street)
Kolkata 700016
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TABLE OF CONTENTS

Chapter	Page
<i>Message from the Principal</i>	5
<i>Editorial</i>	7
<i>List of Professors who obtained the Ph.D. degrees during the year 2014</i>	9
<i>Major and Minor Research Projects undertaken by Professors of St. Xavier's College : (2013 - 2014)</i>	10
<i>Dimension Reduction of Educational Data using Principal Component Analysis</i> Ayan Roy, Kaustuvi Basu, Anal Acharya	11
<i>Analysis of Kolkata as a Tourist Destination— A Data Mining Approach</i> Prasita Mukherjee, Pritha Guha, Riya Samanta, Debabrata Datta	19
<i>Isolation and Characterization of Bacteria from Iron Rich Mine Tailings of Champa District, Chattisgarh, India</i> Debojit Saha, Avishek Shah, Imon Goswami, Anushka Chakravorty, Anindita Bajerjee*, Anindita Banerjee	27
<i>GSM Based Automation and Monitoring System</i> Rana Biswas, Siladitya Mukherjee, Sambhasan Biswas	35
<i>Bioremedial Activity of a Moderate Extremophile from Pharmaceutical Effluent</i> Pramita Chowdhury, Saheli Podder, Debdyuti Nandy, Sushmita Jha, Anuradha Roy, Nilika Bhattacharya, Soumanetra Chandra, Arup Kumar Mitra	42
<i>Linkage Between Job-Employee-Mismatch and Employee turnover intent : A Study</i> Sumana Guha	50
<i>Disease and Women : A New Quest for Identity- in the Light of Vernacular Writings (1870-1930)</i> Tinni Goswami	58



The Principal
ST. XAVIER'S COLLEGE
(Autonomous)

30 Mother Teresa Sarani, (Park Street)
Kolkata - 700 016

9 December 2014

MESSAGE

I am extremely happy to note that the seventh volume of 'Aviskaar' - A Xaverian Journal of Research is being published.

The College has already developed a spacious Central Research Facility for the Science Departments and increasing number of students and research scholars are making use of it.

This journal has an ISSN number both for the printed version and also for the e-version. This volume has contributions from the department of Computer Science. Microbiology, Commerce and History departments. Some of these papers have featured our students as equal stakeholders along with their teachers. This tradition should continue in the future years and I welcome more such meaningful contributions from other Departments of the College.

My congratulations to Prof. Arup Kumar Mitra, the Editorial team and the contributors. Let me take this opportunity to wish you all 'A Grace filled Christmas and a Prosperous New Year 2015.



Rev. Dr. John Felix Raj, S.J.
Principal
St. Xavier's College
(Autonomous)
Kolkata-700 016

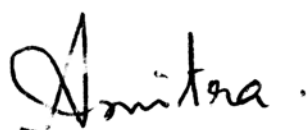


From the Editor's Desk



It gives me great pleasure in editing the seventh volume of Aviskaar-A Xaverian Journal of Research, this year the volume features seven different papers based on original research. The computer science department has contributed immensely in terms of three different papers on Educational data processing, data mining on analysis of Kolkata as a tourist destination, GSM based automation. The two contributions from the department of Microbiology include isolation and characterization of extremophilic bacteria tolerant to heavy metals and its subsequent utilization as a bioremediator. The contribution from the management department describes the linkage between job employee mismatch and employee turnover intent. The contribution from History Department is an account on Disease and women in the light of vernacular writing.

Thus the diverse nature of the paper indicates the dynamism of the journal and I feel encouraged seeing the sizable number of students getting into research projects along with their respective teachers. This trend should continue in our college so that good quality papers will be contributed in the future years. I take this opportunity to wish all my colleagues and students a very happy and prosperous new year ahead.



Dr. Arup Kumar Mitra,

Associate Professor Editor, Xaverian Journal of Research
Post Graduate Department of Microbiology,
St. Xavier's College, Kolkata - 16



List of Professors who obtained the Ph.D. degrees during the year 2014

Awarded Ph.D.

Dr. Ayan Majumber	Commerce(E)
Dr. Sumana Ghosh	Commerce(E)
Dr. Charlotte Simpson	B.Ed
Dr. Saheli Ghosh	Commerce(M)
Dr. Siddhartha Roy (PT)	Commerce(E)
Dr. Sumona Guha	Commerce(M)



Project Grant Received by College during the Year 2014

Name of the Professor	Department	Granting Body	Amount (Rs.)
1. Sanjib kr. Basu	Commerce	UGC (Major)	₹ 40,000/-
2. Sanjib kr. Basu	Commerce	UGC (Major)	₹ 80,000/-
3. Sanjib kr. Basu	Commerce	UGC (Major)	₹ 1,30,000/-
4. Prof. S. S. Saha	Commerce	UGC (Major)	₹ 2,80,400/-
5. Prof. Sanjib Ganguly	Chemistry	UGC (Major)	₹ 2,30,000/-
		UGC (Major)	₹ 1,18,000/-
6. Prof. Jayati Ghosh Dostidar	Comp. Science	UGC (Minor)	₹ 50,000/-
		UGC (Minor)	₹ 2,04,000/-
7. Prof. Argha kr. Banerjee	English	UGC (Minor)	₹ 1,77,500/-
8. Prof. M. Mitra Ghosh	Microbiology	UGC (Minor)	₹ 52,000/-
9. Prof. Saptarshi Roy	Commerce (E)	UGC (Minor)	₹ 21,200/-
10. Dr. Aryadeep Roy Chowdhury	Biotechnology	CSIR	₹ 7,32,000/-
11. Ronita Roy Chowdhury	Biotechnology	CSIR	₹ 2,09,417/-
12. Surupa Chakraborty	Statistics	CSIR	₹ 1,02,243/-
13. Upal Das Ghosh	Microbiology	CSIR	₹ 2,04,000/-
14. Dr. Jhimly Dasgupta	Biotech	DAE / BRNS	₹ 3,96,739/-
15. Dr. Aryadeep Roy Chowdhury	Biotech	DST / SERB	₹ 5,00,000/-
16. Dr. Chandana Barat	Biotech	DST / SERB	₹ 7,00,000/-
17. Dr. Dipankar Chakraborty	Biotech	DST / SERB	₹ 6,50,000/-
18. Dr. Ronita Roy Chowdhury	Biotech	DST / SERB	₹ 4,00,000/-
19. Dr. Dipankar Chakraborty	Biotech	ICAR	₹ 4,95,174/-
20. Dr. Maitree Biswas	Biotech	ICMR	₹ 1,08,000/-
TOTAL			₹ 58,80,273



COMPUTER SCIENCE

Dimension Reduction of Educational Data Using Principal Component Analysis

Ayan Roy and Kaustuvi Basu,
Department of Computer Science,
St Xavier's College,
Kolkata.

Anal Acharya,
Assistant Professor,
Department of Computer Science,
St. Xavier's College,
Kolkata.

Abstract

Principal Component Analysis (PCA) is a statistical multivariate technique that converts inter-correlated dependent variables into a new set of variables using orthogonal transformations. The central goal of this technique is to extract important information from a set of multi-dimensional data and represent it in the form of new variables of lesser dimension. In this paper, the authors have proposed a way of applying PCA to a set of very high dimensional data. Everyday, different organizations, institutions and offices require sending, receiving and analyzing huge data sets. Applying PCA to such huge information set results in reduction of the total number of original variables without much loss of information. This not only reduces the complexity involved in processing and analysis but also reduces the bandwidth and the cost required for data storage and transmission. The authors have implemented the technique in JAVA and verified the methodology on a set of students' records.

Keywords: Eigen vector, Covariance matrix,
Feature Vector, Orthogonal Transformation, Educational Data.

1 Introduction

Principal Component Analysis is a Variable Reduction Procedure. We may have a set of observed variables, possibly of higher dimension. These variables may have some redundancy because of a possible correlation among them. PCA enables us to reduce these variables into smaller number of variables called principal components. . These new variables are smaller than the original set of variables, but they retain most of the sample's information. Principal component analysis (PCA) is a canonical and widely used method for dimensionality reduction of multivariate data. PCA operates either by computing the top Eigen vectors of the sample covariance matrix or by performing singular value decomposition on the matrix of mean centered data [1]. The reconstruction of original data on the basis of the most significant principal components results in minimum deviation from the observed data set. This deviation depends on the number of Eigen Values we

choose for obtaining the principal components. In general, although the original data set contains p variables, often much of the variability can be accounted for by a smaller number (m) of principal components. When there is (almost) as much information in the m components as there is in the original p variables, the original data set consisting of n observations on p variables can be reduced to one consisting of n observations on m principal components [2].

2 An Illustration of PCA

Ideally, Principal Components Analysis (PCA) is applied on high dimensional multivariate data and its effects on such huge sets of information are profound. However, for the sake of simplicity we initially describe the working of PCA on a set of 2-Dimensional data and finally illustrate how extracting the most significant principal component simplifies the original set without losing much information. The following steps are followed to implement the concept of PCA:

- ☐ The first step involves obtaining the sample data set. In this case, we initially start with a 2-Dimensional data. The adjoining figure is a plot of the given information along X and Y axes.

Table 1 Original Data Points

X	2.6	0.6	2.1	2	3.2	2.4	2.1	1	1.6	1.2
Y	2.5	0.8	3	2.1	3.1	2.8	1.7	1.2	1.7	1

- ☐ Next we have to subtract the mean from each of the data dimensions. The mean subtracted is the average across each dimension. So, all the x values have Mean_x (the mean of the x values of all the data points) subtracted, and all the y values have Mean_y subtracted from them. This produces a data set whose mean is zero. This is important since if the data are not normalized a large variance will result in the next step.

Table 2 Adjusted Data

X	0.72	-1.28	0.22	0.12	1.32	0.52	0.22	-0.88	-0.28	-0.68
Y	0.51	-1.19	1.01	0.11	1.11	0.81	-0.29	-0.79	-0.29	-0.99

- ☐ In this step we mainly focus on finding out the covariance matrix of the adjusted data. It is very clear that as it is a 2 dimensional data, the covariance matrix would be a 2×2 matrix. Instead of finding the covariance, we could have also calculated the correlation matrix. The reason for doing this is to identify the correlated variables in our example, so that reducing them to a set of un-correlated variables eliminates a certain amount of redundancy in the data thus identifying only the most significant dimensions that are enough to represent the given information. The covariance matrix obtained given below:

Table 3 Covariance Matrix

0.621777778	0.599777778
0.599777778	0.707666667

- ☐ The next step is to calculate the Eigen vectors and Eigen values of the square covariance matrix found above. Since, the covariance matrix is symmetrical, the resultant Eigen vectors will be orthogonal, i.e., all the Eigen vectors will be at right angles to each other. This means we can represent data in terms of these vectors as we do in terms of X or Y axes. Another, important concept of PCA is to keep the Eigen vectors of unit length so that all Eigen Vectors are of equal length. This does not alter the vectors as their magnitude does not affect their nature provided their directions remain the same. The Eigen Vectors and Eigen Values for the given data is shown in Fig 1.

```
Eigen Vector-1:
0.731921362
-0.681389111

Eigen Value(1)=0.063408986

Eigen Vector-2:
0.681389111
0.731921362

Eigen Value(2)=1.266035458
```

Fig 1. Screenshot of Eigen Vectors and values

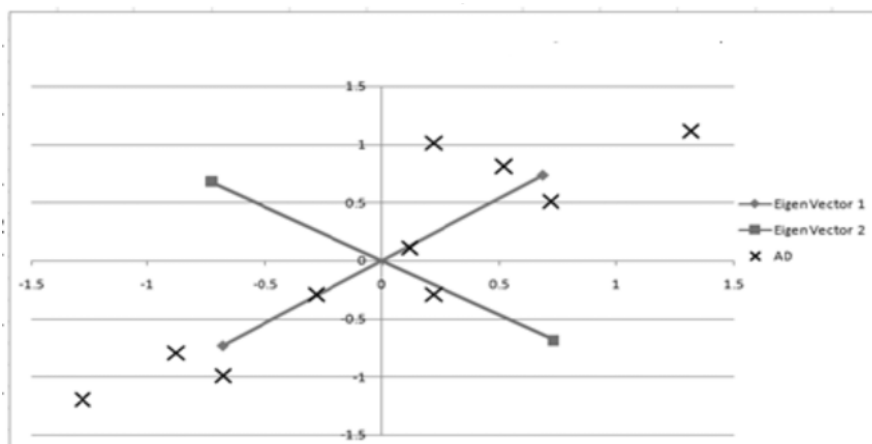


Fig 2. Plot of Adjusted Data with the Eigen vector Overlaid on Top

- ☐ The main objective of PCA is to obtain the most significant components that are enough to represent the given set of data efficiently. Thus, the next step after obtaining the Eigen vectors and the Eigen values is to arrange them in order of significance, from highest to lowest. The Eigen Vector with the highest Eigen value is known as the principal component. The first Eigen Value in this arrangement would be the one that will be able to reconstruct the original data with the closest accuracy. In this way, we may choose to ignore the lesser significant vectors. We do lose some data but if the vectors are small then the loss of data is not much. Ignoring the lesser significant dimensions would result in a new data set with lesser dimensions as the original. This is how PCA achieves data compression or dimension reduction. In general, if we have n dimensions and we choose p significant Eigen vectors then the final result will contain p dimensions. We form the Feature Vector which contains the Eigen Vectors in the order of significance.


```
Feature Vector:
0.681389111    0.731921362
0.731921362    -0.681389111
```

Fig 3. Screenshot of Feature vector

The Eigen Value for the Eigen Vector-1 is the largest as shown in Fig-2. Hence, we may choose Eigen Vector-1 to reduce the dimensions of our data. Our Feature Vector is shown in Fig 4.

```
Feature Vector:
0.681389111
0.731921362
```

Fig 4. Screenshot of the Most Significant Feature Vector

☐ The final step in PCA is to derive the new data. This is done using the following formula:

$$\text{FinalData} = (\text{FeatureVector})^T \times (\text{DataAdjustVector})^T$$

This gives us the required principal components. Originally, our given data is in terms of the X and Y axes. Since, the Eigen Vectors obtained in the process are orthogonal, they can be thought of as new axes representing our original data. The principal components and their corresponding plot obtained are shown in Table 4 and Fig 5 respectively.

Table 4 Principal Components using both Eigen Vectors

0.864	-1.743	0.889	0.162	1.712	0.947	-0.062	-1.178	-0.403	-1.188
0.179	-0.126	-0.527	0.013	0.21	-0.171	0.359	-0.106	-0.007	0.117

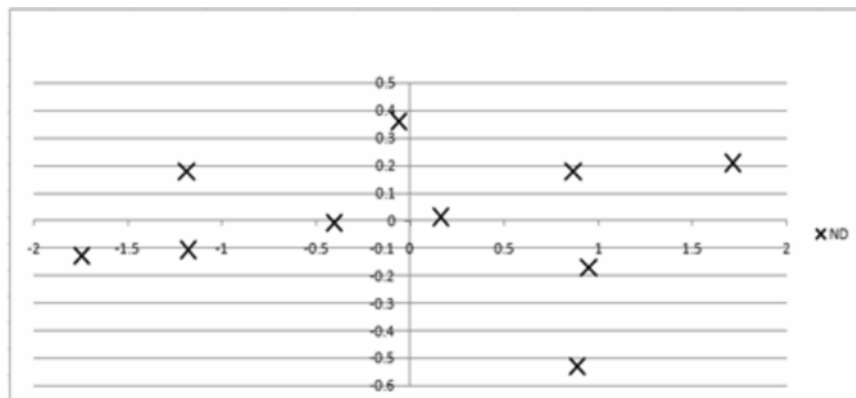


Fig 5. Plot of Principal Components

The principal components shown in Table 4 are obtained using all Eigen vectors. We may choose to ignore the lesser Eigen Vector and use the Feature Vector of Fig 5 to obtain the Final Data with only the most significant dimension. The most significant principal component is shown in Table 5.

Table 5 Principal Components using Most Significant Eigen Vector

0.864	-1.743	0.889	0.162	1.712	0.947	-0.062	-1.178	-0.403	-1.188
-------	--------	-------	-------	-------	-------	--------	--------	--------	--------

The data is obtained based on the contributions of each Eigen Vector. In Table 4 both Eigen Vectors contribute towards the calculation of the principal components. In Table 5, we ignore the contributions from the less significant Eigen Vector. All the steps shown above illustrate how PCA is applied in practice. The PCA scores or the principal components obtained above is sent to the receiver who may reconstruct the original data using the formula:

$$\text{OriginalData} = (\text{FeatureVector}^T) \times \text{FinalData} + \text{Mean}$$

Table 6 Reconstructed using Most Significant Eigen Vector

X	2.469	0.692	2.486	1.991	3.046	2.525	1.838	1.077	1.605	1.071
Y	2.662	0.714	2.641	2.109	3.243	2.683	1.994	1.128	1.695	1.121

We analyze the results obtained above:

The total variance calculated from the Covariance matrix in Table-4:

$$0.621777778 + 0.707666667 = 1.329444445$$

Variable X constitutes **46.769%** of the total variance

Variable Y constitutes **53.230%** of the total variance

Without applying PCA, if we need to reduce the given data into any one of the dimensions, we end up losing either **46.769%** or **53.230%** of the data. In other words, we lose about half the original data.

Using PCA, the total variance calculated from the Eigen Values in Fig 2:

$$1.266035458 + 0.063408986 = 1.329444444$$

The first principal component constitutes **95.230%** of the total variance

The second principal component constitutes **4.769%** of the total variance

Thus, by transforming the data set to PCA scores along the most significant axis (Principal Eigen Vector) we lose only about **4.769%** of the original data thus retaining **95.230%** of it. Hence, we can not only choose to represent a data set in terms of the most important dimensions, but the receiver of this data can also reconstruct the original information with more than 95% accuracy.

3 Application of PCA on Educational Data

So far, we have illustrated how PCA works on a data set with two dimensions. Ideally, PCA is applied on multidimensional data sets, transmission of which incurs a heavy amount of channel bandwidth consumption and complexity at both ends. In this section we apply the same technique on a set of students' records with 15 dimensions and 10 records. The steps followed will remain the same. Fig 6 shows a screenshot of a typical data set.

Gender	Caste	Religion	F_Size	Board	S_Origin	Income	Board Marks	H_Day	Atten	Mid_Sem	Medium	School	P_Tution	Percent
1	1	1	3	1	1	3	1	3	3	2	1	1	1	85
2	1	1	4	2	0	4	2	2	2	2	1	1	0	75
1	2	3	5	2	1	1	4	2	4	6	2	2	0	35
2	1	3	3	1	1	2	3	3	4	6	2	1	1	36
1	2	4	4	3	1	3	2	3	2	3	2	3	1	65
1	3	2	6	2	0	2	4	3	3	5	1	1	0	57
1	2	3	4	1	0	2	2	2	3	4	1	1	1	33
1	4	1	3	3	1	3	2	1	2	2	2	2	1	74
2	1	1	3	2	0	4	2	3	1	1	1	1	1	79
1	3	3	3	1	1	1	4	1	5	5	1	1	1	84

Fig 6. Student's Data Set

Gender- 1: male, 2: female ; **Caste-** 1: General, 2: SC, 3: ST, 4: OBC ; **Religion-** 1: Hindu, 2: Muslim, 3: Christian, 4: Others; **Board-** 1: ICSE 2: CBSE 3: State Boards 4: Others; **S Origin-** 1: West Bengal, 2: Other States; **Income-** 1: $\leq 10K$, 2: $> 10K$ but $\leq 20K$, 3: $> 20K$ but $\leq 30K$, 4: $> 30K$ but $\leq 40K$, 5: $> 50K$; **Board Marks-** 1: $\geq 90\%$, 2: 89% to 80% , 3: 79% to 70% , 4: 69% to 60% , 5: 59% to 50% , 6: $< 50\%$; **H Day-** 1: < 3 hours, 2: 3 to 6 hours, 3: 7 to 9 hours, 4: > 9 hours; **Atten-** 1: $\geq 90\%$, 2: 89% to 80% , 3: 79% to 70% , 4: 69% to 60% , 5: 59% to 50% , 6: $< 50\%$; **Mid Sem-** 1: $\geq 90\%$, 2: 89% to 80% , 3: 79% to 70% , 4: 69% to 60% , 5: 59% to 50% , 6: $< 50\%$; **Medium** - 1: English, 2: Bengali, 3: Hindi, 4: Others ; **School-** 1: Urban, 2: Municipal, 3: Rural ; **P tution-** 1: Yes, 0: No.

3.1. Test Cases :

(a) No. of dimensions reduced to = **2**

Most significant 2 Eigen Values

1. 435.605512267 (97.65% contribution to total variance)

2. 5.003496571 (1.12% contribution to total variance)

22.810	-0.602
12.856	-1.840
-27.499	1.493
-26.421	0.275
2.704	-0.787
-5.449	1.388
-29.256	-1.470
11.870	-0.684
16.943	-2.845
21.442	5.071

Fig 7. Principal Components obtained using Two Eigen vectors

1.379	1.944	1.367	3.264	2.015	0.565	3.340	1.955	2.261	2.199	1.859	1.167	1.351	0.831	84.992
1.491	1.632	1.405	3.396	2.079	0.421	3.574	1.677	2.510	1.808	1.767	1.259	1.398	0.808	74.986
1.130	2.240	3.371	4.498	1.460	0.724	1.180	3.663	2.229	4.101	6.134	1.686	1.446	0.525	34.997
1.250	1.971	3.074	4.392	1.596	0.596	1.695	3.190	2.411	3.516	5.377	1.667	1.464	0.558	35.987
1.379	1.833	1.946	3.688	1.901	0.520	2.886	2.257	2.406	2.485	2.987	1.368	1.406	0.732	64.941
1.159	2.293	2.669	4.012	1.618	0.740	1.802	3.218	2.117	3.645	4.722	1.464	1.391	0.640	56.964
1.419	1.569	2.783	4.335	1.761	0.408	2.319	2.591	2.697	2.757	4.560	1.684	1.501	0.584	33.043
1.377	1.888	1.686	3.496	1.951	0.542	3.085	2.126	2.337	2.363	2.484	1.276	1.381	0.777	74.083
1.593	1.420	1.061	3.240	2.212	0.320	4.083	1.228	2.641	1.266	0.946	1.211	1.404	0.853	78.991
0.822	3.212	2.639	3.679	1.408	1.164	1.036	4.095	1.392	4.859	5.164	1.218	1.258	0.693	84.015

Fig 8. Reconstructed Data obtained using Two Principal Components

(b) No. of dimensions reduced to = **5**

Most significant 5 Eigen Values

1. 435.605512267 (97.65% contribution to total variance)

2. 5.003496571 (1.12% contribution to total variance)

3. 1.916073317 (0.43% contribution to total variance)

4. 1.402741794 (0.31% contribution to total variance)

5. 1.051243406 (0.24% contribution to total variance)

22.810	-0.602	-1.740	-0.253	0.176
12.856	-1.840	-0.383	1.204	-0.172
-27.499	1.493	0.714	0.333	0.198
-26.421	0.275	-1.899	-0.790	0.305
2.704	-0.787	1.637	-1.368	2.209
-5.449	1.388	1.117	2.533	0.284
-29.256	-1.470	-0.449	-0.450	-1.100
11.870	-0.684	2.246	-1.150	-1.725
16.943	-2.845	-0.585	0.501	0.146
21.442	5.071	-0.660	-0.558	-0.321

Fig 9. Principal Components obtained using Five Eigen Vectors

1.655	0.926	1.406	2.588	1.180	0.626	3.321	1.662	2.619	2.699	2.071	0.973	0.846	1.053	85.002
1.637	1.397	0.851	3.962	1.817	0.038	3.639	2.009	2.706	1.809	1.906	0.897	0.868	0.458	74.995
1.041	2.527	3.418	4.976	1.835	0.654	1.225	3.870	2.272	3.852	6.121	1.740	1.672	0.351	35.005
1.518	0.853	3.361	3.368	0.720	0.827	1.648	2.708	2.768	4.103	5.576	1.588	1.093	0.963	35.997
1.073	1.927	3.756	3.899	3.103	1.156	2.977	2.128	3.069	1.989	3.062	2.177	3.058	0.963	64.999
1.166	2.595	2.011	5.974	2.126	0.025	2.007	4.191	2.542	3.056	4.908	1.071	1.168	-0.279	56.999
1.428	1.814	2.316	3.663	1.387	0.437	2.199	2.337	2.093	3.015	4.361	1.605	1.130	0.803	33.000
0.870	3.941	1.359	3.129	2.858	0.773	2.894	1.957	0.785	1.984	1.776	1.719	1.990	1.015	73.999
1.731	0.996	0.911	3.388	1.923	0.173	4.123	1.322	2.917	1.369	1.095	1.017	1.096	0.735	79.004
0.882	3.023	2.611	3.053	1.050	1.291	0.967	3.815	1.231	5.125	5.124	1.213	1.079	0.739	84.000

Fig 10. Reconstructed Data obtained using Five Principal Components

3.2. Analysis :

The following table is a summary of the all operations done on the set of students' records. The table shows the difference of the reduced data obtained after applying PCA on the original data using the most significant 2, 3, 4 and 5 dimensions.

	2-Dimensions	3-Dimensions	4_Dimensions	5_Dimensions
Gender	0.3687	0.2566	0.2622	0.2725
Caste	0.6836	0.3784	0.3678	0.1895
Religion	0.5265	0.5346	0.4209	0.311
F_Size	0.6812	0.5847	0.2615	0.1876
Board	0.6141	0.202	0.2009	0.1693
S_Origin	0.4106	0.4073	0.2136	0.224
Income	0.2116	0.2078	0.1879	0.175
Board_Marks	0.4428	0.431	0.2598	0.2655
H_Day	0.587	0.5808	0.5578	0.274
Atten	0.3721	0.1761	0.1698	0.1335
Mid_Sem	0.2684	0.2406	0.2075	0.1668
Medium	0.4006	0.3372	0.202	0.2166
School	0.5534	0.3595	0.2586	0.1248
P_Tution	0.3945	0.3703	0.1807	0.1653
Percent	0.0274	0.0273	0.0326	0.0022

Fig 11. Difference from the Original Data Records for each Dimension

The Eigen Value **435.605512267** contributes **97.65%** to the total variance. Thus, leaving all other 11 dimensions will result in a loss only **2.35%** of the total data.

4 Limitations of PCA

Two key disadvantages of PCA are :

- [1] The covariance matrix is difficult to be evaluated in an accurate manner.
- [2] Even the simplest invariance could not be captured by the PCA unless the given data explicitly provides this information [5].

It may be noted that the PCA is based on the following assumptions:

- ☐ The assumption that the dimensionality of data can be efficiently reduced by linear transformation.
- ☐ The assumption that most information is contained in those directions where input data variance is maximum.

As it is evident, these conditions are by no means always met. For example, if points of an input set are positioned on the surface of a hyper sphere, no linear transformation can reduce dimension (nonlinear transformation, however, can easily cope with this task). Another disadvantage of the PCA consists in the fact that the directions maximizing variance do not always maximize information.[6]

5 Conclusion and Future Scope

Principal component analysis is a powerful tool for reducing a number of observed variables into a smaller number of artificial variables that account for most of the variance in the data set. It is particularly useful when we need a data reduction procedure that makes no assumptions concerning an underlying causal structure that is responsible for co-variation in the data. [3] In this paper we have proposed a method for dimensionality reduction using Principal Component Analysis. By exploiting the structure of the principal components of a set of features, we can choose the principal features which retain most of the information both in the sense of maximum variability of the features in the lower dimensional space and in the sense of minimizing the reconstruction error. This method should be used in the cases where the cost of using all of the features can be very high, either in terms of computational cost, measurement cost or in terms of reliability of the measurements. The most natural application of this method is in the development stage, and can be used to pick out a feature vector out of a large possible feature vector, as shown in the first experiment. It can also be used for reconstruction of the original large set of features [4].

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COMPUTER SCIENCE

Analysis of Kolkata as a Tourist Destination— A Data Mining Approach

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Abstract

This study aims at identifying the factors influencing the decision of a tourist to visit a place using factor analysis techniques. The present study's objective is to examine the meaning and significance of different aspects of tourist places on a general that affects tourism in India. The paper also attempts to examine the relationship between these different aspects and its importance to the people. The study has been conducted in Kolkata in West Bengal which is situated in north-eastern part of India. This city is cosmopolitan in nature and houses a big part of the country's population. The data of this study were collected from people who have been to not only Kolkata but also to different parts of this country and to foreign lands. The data from 125 respondents on 25 attributes were analyzed in this study using the Statistical Package for Social Sciences (SPSS) version 20.

Keywords: Data Mining, Factor Analysis, PCA, SPSS, Tourism

1 Introduction

India is a large and populous country with a great past and a great tradition. It can boast of one of the oldest civilized life, and as such it must be ranked as one of the great civilizations of the world. India has three main recreation attributes: cultural, historical and natural. On one hand India has several main varieties of tourism destination in different areas of the country like a) monumental heritage related with art and architecture b) the religious heritage like pilgrims and temples c) the natural heritage d) traditional arts and crafts e) music and dance etc. On the other hand, it suffers from some serious problems like tourist

security, health and hygiene, cleanliness etc. And for this reason India is not able to make the best of its tourism potential as yet. Still tourism is a very vital component in the GDP.

Tourism is the largest service industry in India. According to [11], the sector's direct contribution to GDP was US\$ 34.7 billion in 2012 and a total of US\$ 115.5 billion which included both leisure and business travel. Foreign visitor revenues reached US\$ 18.2 billion and business travel constitutes a significant 27.7% of the entire contribution. The number of Foreign Tourist Arrivals (FTAs) in India during 2010 increased to 5.78 million as compared to 5.17 million in 2009. The growth rate of 11.8% in 2010 for India was better than UNWTO's projected growth rate of 5% to 6% for the world in 2010. Tourism continues to play an important role as a foreign exchange earner for the country. In 2010, foreign exchange earnings (FEE) from tourism were US\$ 14.19 billion as compared to US\$ 11.39 billion in 2009, registering a growth of 24.6%.

2 Objectives of the Study

This study has two specific objectives in order to understand the tourism using the ideas of data mining which is a knowledge discovery process from a large data set [1].

- [1] To identify the relationship between the different aspects of a place that the tourists come across.
- [2] To analyze the relationship between these aspects and importance of it to the tourists.

2.1. Different Attributes Used :

The following 25 attributes were used:

1. **Information** – Availability of information about a place on newspapers, magazines, internet or any social media.
2. **Info_of_the_Recreation_Spots** – Availability of information about the recreational areas.
3. **Reach** – Availability or number of options of transportation to go to the various places.
4. **Reach_Recreation_Spot** – Availability or number of options of transportation to go to the local places.
5. **Public_Services** – Availability of services like post office, market etc.
6. **No_of_Recreation_Spots** – Number of places to visit.
7. **Cosmopolitan** – Whether the place is a cosmopolitan city or not.
8. **Information_Center** – Services of the information center.
9. **Maintenance** – Maintenance of the different spots with cultural heritage.
10. **Vacation** – Condition of all the services during festive season or vacation.
11. **Hygiene** – Related to pollution or cleanliness.
12. **Politics** – If the tourists are disturbed or harmed because of local politics.
13. **Behavior** – Behavior of the people offering services to the tourists. Examples include guides, taxi drivers, police etc.
14. **Population** – How the crowd treats the people considered in attribute number 12.
15. **Accommodation** – Availability of the places to stay.
16. **Food** – Availability and variety of foods.

- 17. Weather** – Condition of the weather and its effect on a place.
- 18. Expense** – How expensive the place is.
- 19. Safety** – Security from theft, robbery, rape etc.
- 20. Accidents** – How much accident prone the place is.
- 21. Transportation** – Availability of the transportation services.
- 22. Roads_Footpaths** – Condition of the roads and the footpaths.
- 23. Traffic** – Condition of traffic and how well it is managed.
- 24. Entertainment** – Availability of places of entertainment like theatres, pubs etc.
- 25. Private_Services** – Availability of malls, popular restaurants etc.

2.2. Methodology of the Study :

The study tries to identify the relationship between the different attributes or aspects that the tourists come across during their visit and tourists' satisfaction. The sample population for this study composed of respondents from the different age groups. No particular attempt was made to apply a random sample or to select particular segments. Data from 125 respondents have been analyzed in this study using the Statistical Package for Social Sciences (SPSS) version 20. Statistical analyses such as factor analysis, correlation analysis, were used to generate the result. Factor analysis was conducted to create correlated variable composites from the original 25 attributes and to identify a smaller set of dimensions, or factors, that explain most of the variances between the attributes. In this study, factors were retained considering both the cumulative percentage of variance and the Eigen value rule.

3 Factor analysis and its type

Factor analysis is a multivariate statistical procedure [3] that has many uses that are briefly stated below:

[a] Factor analysis reduces a large number of variables into a smaller set of variables (also referred to as factors).

[b] It also establishes the relationship between the unobserved factors with the observed ones.

There are two major classes of factor analysis: **Exploratory Factor Analysis (EFA)**, and **Confirmatory Factor Analysis (CFA)**. In EFA, the investigator has no expectations of the number or nature of the variables and is exploratory in nature. That is, it allows the researcher to explore the main dimensions to *generate* a theory, or model from a relatively large set of items. Whereas, in CFA, the researcher uses this approach to *test* a proposed theory, or model and in contrast to EFA, has assumptions and expectations based on priori theory regarding the number of factors, and which factor theories or models best fit.

This work has actually used EFA and not just factor analysis.

To do the study, it is required to check whether the database is suitable for Factor Analysis or not [4]. The following parameters are considered for this:

N:p Ratio

The sample to variable ratio, often denoted as $N:p$ ratio where N refers to the number of participants and p refers to the number of variables, is recommended to check if the database at hand is suitable for factor analysis. A threshold of 3:1 ratio is generally used. Most researchers feel that it is the minimum ratio required to obtain a fair result. Though higher the ratio is, better will be the result.

Factorability of the Correlation Matrix – A correlation matrix should be used in the process displaying the relationships between individual variables. It is recommended to inspect the correlation matrix (often termed **Factorability of R**) for correlation coefficients over **0.30**. These loadings can be categorized using another rule of thumb as follow:

± 0.30 = minimal, ± 0.40 = important and ± 0.50 = practically significant.

If no correlations go beyond 0.30, then factor analysis is not the appropriate method to use. In other words a factorability of 0.3 indicates that the factors account for approximately 30% of the relationship within the data, or in a practical sense, it would indicate that a third of the variables share too much variance.

Prior to the extraction of the factors, several tests should be used to assess the suitability of the respondent data for factor analysis. These tests include **Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy** and **Bartlett's Test of Sphericity**. The **KMO index**, in particular, is recommended when the cases to variable ratio are less than **1:5**. The KMO index ranges from **0 to 1**, with **0.50** considered suitable for factor analysis. The Bartlett's Test of Sphericity should be significant (**$p < 0.05$**) for factor analysis to be suitable.

4 Selecting a method for Factor Analysis

The aim of the data extraction is to reduce a large number of items into factors. In order to produce scale uni-dimensionality and to simplify the factor solutions several criteria are available.

- ☒ Cumulative percentage of variance and **eigen value > 1 rule**
- ☒ The **Scree Test**
- ☒ Parallel analysis

Another consideration when deciding how many factors are to be analyzed is whether a variable might relate to more than one factor. Rotation method produces a more interpretable and simplified solution. The aim of rotation is to obtain something called the **simple structure**.

In other words, the rotational method tends to make the difference between the high item and low item loading all the more prominent to make the decision-making easier. There are two common rotation techniques: **orthogonal rotation** and **oblique rotation**. There are several methods to choose from both rotation options, for example, **orthogonal varimax/quartimax, oblique oblimin/promax** etc. Orthogonal Varimax rotation is the most common rotational technique used in factor analysis, which produce factor structures that are uncorrelated. In contrast, oblique rotation produce factors that are correlated, which is often seen as producing more accurate results for research involving human behaviours. Regardless of which rotation method is used, the main objectives are to provide easier interpretation of results, and produce a solution that is better.

Whichever rotated solution produces the best fit and factorial suitability, both intuitively and conceptually, should be used. Once this has been assessed, the researcher then examines items that do not load or are unable to be assigned to a factor using the above guides and makes a decision whether the items should be discarded. For example, the item might load on several factors, not load on any factors, or simply not conceptually fit any logical factor structure.

Interpretation involves the researcher examining which variables are attributable to a factor, and giving that factor a name. For example, a factor may have included five variables which all relate to intelligence; therefore the researcher would create a label of "intelligence" for that

factor. It is beneficial to have at least two or three variables loading on a factor so it can be given a meaningful interpretation. The labeling of factors is a subjective and theoretical. The reason for thorough and systematic factor analyses is to isolate items with high loadings in the resultant pattern matrices. In other words, it is a search to find those factors that taken together explain the majority of the responses.

5 Findings of the Study

The finding is divided into two major sections. The first section provides the demographic characteristics of the respondents. The second section presents results on the respondents' satisfaction with 25 attributes.

Demographic Characteristics of the Respondents (N = 125)

The gender distribution of the respondents was not equal, with **46.4% female respondents** and **53.6% male respondents**. The dominant age group of the respondents was **18 to 20 years (77.6%)**, followed by **22 to 40 years (9.6%)**, **41 to 60 years (8.8%)** and **61 years and above (4.0%)**. Hence 61 years and above (4.0%) made up the smallest group, representing only 4.0% of the respondents. Most of the respondents (**68.8%**) live in Kolkata, and **27.2%** of the respondents live in other places or cities of India, whereas **4.0%** of the respondents lived in foreign countries.

Table 1 Demographic Characteristics of the Respondents (N = 125)

Variables	Frequency	Percentage (%)
Gender - Male	67	53.6
- Female	58	46.4
Age(in year) -		
18 - 21	97	77.6
22 - 40	12	9.6
41 - 60	11	8.8
>61	5	4.0
States- Kolkata	86	68.8
- Other places in India	34	27.2
- Abroad	5	4.0

Result on the respondents' and satisfaction with 25 variables

Initially for this research work, 25 attributes were considered. Factor analysis is variable redundancy technique observed on these 25 attributes and gave 8 factors. The analysis started by observing through correlation matrix correlation existed between maximum of the variables. A correlation matrix shows the relationships between individual variables. That means Factor Analysis is recommended.

The output of factor analysis is obtained by requesting Principal Components Analysis and specifying a rotation. Oblique rotation is used for the purpose. The Scree Plot shows that 8 factors can be extracted.

Rotated Component Matrix ^a								
	Component							POPULARITY
	1	2	3	4	5	6	7	8
Info	.179	.130	.121	-.035	.043	.021	.056	.901
InfoRec	.327	.074	.141	-.015	-.006	-.049	.189	.815
ReachKol	-.132	-.011	.837	-.010	-.078	-.039	-.082	.103
ReachRec	.140	-.016	.843	-.059	.152	-.112	-.069	.070
PubServ	.494	.022	.729	-.041	-.018	.113	.041	.061
NoOfSpo	.323	-.038	.823	-.119	.012	.038	-.089	.053
Cosmo	.281	.754	.069	.056	-.067	.114	.060	-.002
InfoCeter	.481	-.050	.029	.024	.785	.144	.029	.097
Maint	.802	-.047	.051	-.071	.485	.056	-.060	.159
Vac	.187	.035	.013	.130	.843	.165	.083	-.071
Pollut	.744	-.076	.094	-.028	.552	.041	-.053	.137
Poli	.921	-.091	.161	-.123	-.076	-.017	-.027	.104
Behav	.911	.000	.135	-.179	-.056	-.043	-.057	.161
Popu	.916	.000	.173	-.191	-.046	-.019	-.058	.139
Accomo	-.118	.891	-.059	.001	.082	.003	.027	.066
Food	-.198	.872	-.032	.057	-.011	.045	.109	.080
Weat	-.038	.878	-.074	.054	.005	.104	.099	.080
Cheap	-.166	.885	.050	.049	-.044	.062	.032	-.006
Secu	-.037	.053	-.051	.072	.147	.961	.045	-.009
Accid	.047	.032	.001	.019	.111	.969	.033	-.010
ModTran	-.235	.110	-.038	.897	-.109	.065	.177	.052
TradTran	-.142	.025	-.077	.956	.115	.024	.035	-.059
Traffic	-.071	.064	-.077	.958	.112	.020	.019	-.040
Entertain	-.074	.155	-.080	.077	.001	.075	.942	.095
PrivServ	-.063	.111	-.112	.048	.080	.007	.946	.111

Extraction Method: Principal Component Analysis

Fig 1. Rotation Matrix

- Factor 1** consists of 3 important attributes Popu, Poli and Behav. Since all these three are closely related to the characteristics of the people living in Kolkata, it was named as **People**.
- Factor 2** consists of ModTran, TradTran and Traffic. These three closely represents the aspects of transportation or the elements that involves transportation and hence was named as **Transportation**.
- Factor 3** Accid and Secu load highly on factor 3. Since these are the security elements of Kolkata, this was named as **Security**.
- Factor 4** Entertain and PrivServ load heavily on factor 4. These attributes represents elements of Services provided by the Private Companies and hence the name **Private Services** was given.
- Factor 5** ReachKol, ReachRec, PubServ and NoOfSpo are highly loaded on factor 5. These attributes shows how much or how many resources is provided in the city and hence the name **Resources** was assigned.

Factor 6 Vac, InfoCenter, Pollut and Main represent those attributes or aspects that the government should take care of. Since these attributes loads heavily on factor 6 it was named as **Government Services**.

Factor 7 InfoKol and InfoRec represent those factors which depict the popularity of the city. Availability of Information regarding the different aspects of Kolkata shows how much popular it is. Since these attributes are heavily loaded on factor 7 it was named as **Popularity**.

Factor 8 Cheap, Weat, Food, Accomo represent those factor which have the maximum impact on anyone living in the city. Since these attributes are the most heavily loaded on factor 8 this was named as **Living Standard**.

All the variables are very important and may influence the tourist satisfaction of Cultural heritage destinations in Kolkata. But applying statistical tool like factor analysis for reducing the number of variables, the relevant information may be shared towards explaining the tourist satisfaction.

6 Conclusion

From these studies, it has been emphasized that the identification of tourists' characteristics and an investigation of the relationship between the attributes and tourists' satisfaction are needed. It is argued that such research efforts would help tourism practitioners and planners to have a better understanding of cultural heritage tourism and to formulate better strategy and planning about cultural heritage tourism. With these observations in mind, this current study was conducted. Tourists are satisfied in Kolkata and we have to act smart here and first, we have to create more information outlets in various markets. Second, Indian tourism industry and governments should work more closely with the cultural heritage areas to spread the awareness and remove hurdles. Finally, we have to work towards getting tie-up with various travel agencies & tour operators to build up awareness of quality among domestic and international tourists. There is no doubt that Kolkata has immense potential and will receive more domestic and international tourists in future also to be the leader in providing cultural heritage tourism in the world.

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MICROBIOLOGY

Isolation and Characterization of Bacteria from Iron Rich Mine Tailings of Champa District, Chattisgarh, India

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Abstract

The present day study was conducted to determine the culturable bacterial profile from Champa (Chattisgarh, India) and analyse their metal and antibiotic tolerance. In addition to insitu high metal concentration in soil the areas receives huge daily metal deposits from iron mine tailings from the nearby firms and industrial sectors. The bacteria present in iron ore mine tailings often show diverse features including different biochemical properties, ability to grow in a variety of media, tolerance towards varying physical conditions and resistance to certain heavy metals and commonly used antibiotics. Champa is a small city as well as a municipality situated at bank of Hasdeo river in Janjgir-Champa district in the state of Chhattisgarh, India. A single strain of bacteria named as C_1 was used for our study which showed whitish translucent colony morphology and contained short rod, non-motile Gram-negative bacteria. Biochemical tests were done which showed C_1 was capable of utilizing citrate as its carbon source and were positive for nitrate reduction test and oxidase but were negative for catalase. C_1 was able to grow profusely on citrate agar too. The sample was also checked for resistance of bacteria against certain heavy metals like iron, copper, manganese, cobalt, lead and zinc. Phylogenetic analysis of their 16S rDNA genes revealed that they belong to one main taxonomic group-the Actinomycetes. Further microbiological studies show prospects of these being prospective candidates for bioremediation.

Keywords: Iron, Citrate Agar, Nitrate utilization test, Iron isolating medium, Metal tolerance, antibiotic tolerance, 16S rDNA.

1 Introduction

Environmental pollution and its subsequent degradation has become rampant over the past few decades and has been increasing at an alarming rate ever since. Among the huge

number of toxic and chemical substances that routinely contaminate the environment, heavy metals happen to be major contributors. Heavy metal pollution has affected large sections of soil and water bodies rendering them unfit for human use and paving the way for threats of bio-accumulation, relay toxicity, bio-magnification and secondary poisoning still remains. Heavy metals such as copper(Cu), manganese(Mn), iron(Fe) and chromium (Cr) are important environmental pollutants, particularly in areas with high anthropogenic pressure. The risk of contaminants accumulating in soil, environment and crops due to mining, offshore drilling, land exploitation for extraction of coal ore, etc. are of serious concern. Heavy metals have been reported to produce mutagenic, tetratogenic, neurotoxic and carcinogenic effects even at low concentrations (Waalkes et al. 1994;A-Saleh et al. 1996). Human beings have also been known to develop several diseases like cardiovascular problems, lobular dysfunctions in kidney and nervous disorders due to metal toxicity. Majority of their harmful effects are manifested through pollution of soil and water. With rapid industrialization and mechanization iron is in huge demand and thus serves to be the main heavy metal pollutant. Dwindling natural resources and their rampant spoilage has caused the development of new disciplines and new strategies to combat their ill effects. Bio remediation is one such emerging strategy which utilizes living organisms to counter the harmful effects of pollution and reduce their impact on natural resources.

Exploring the microbial habitat having elevated level of heavy metals has an important implication of microbial heavy metal tolerance because the oxidation state of a particular heavy metal relates to the solubility and toxicity of the metal itself. The metal accumulating or utilizing capability of a microorganism can be exploited to remove,concentrate and recover metals from mine tailings and industrial effluents(Malekzadeh et al., 2002). Microorganism-based remediation techniques,such as bioremediationshow potential for their ability to degrade and detoxify certain metal contaminants(Sherameti and Varma,2011).

This study concentrates on isolation and characterization of bacteria from mine tailing samples procured from Champa, Chattisgarh which harbors a number of iron mines; as a result of which the soil therein is rich in iron and so the bacteria growing in it is naturally adapted to the iron-abundant environment. The naturally stressed conditions,barren, iron rich soil provides a suitable niche to isolate various resistantmetal tolerant bacteria and explore their potentialities as bioremediators.Biochemical studies and other assays showed the bacteria to be resistant to most commonly used antibiotics with maximum resistance for streptomycin.Maximal tolerance to iron concentration was also noted showing its adaptability to its environment. Studying and characterizing the bacteria thus provides information regarding their resistance to iron as well as the prospect of using them for bio-remediation.

MATERIALS AND METHODS

Field site,soil sample and parameters of study

Mine tailings samples were collected from the vicinity of Prakash Iron Industries in Champa, Chattisgarh,India(co-ordinates: 21.6°N and 82.3°E) and designated as sample "C1".

Determination of physical characteristics

The mine tailing sample was collected from an industrial area and thus was rich in iron. It had a reddish brown colour and rough texture. When added to 9ml of distilled water and allowed to stand, the entire suspension takes up a faint reddish brown tingeand was thus assumed to be probably acidic. The pH was measured with the help of pH paper and pH meter to check acidity. If found to be acidic then it would have high chances of harboring iron tolerant bacteria. The electrical conductivity was also measured. 1 gram of the sample C1 was added to 9ml of sterile water and was shaken for about 15min. It was allowed to

stand for 30 minutes. The mixture assumes a reddish brown colour implying that the soil has high iron content. The characteristic of the tested soil sample is shown in Table 1. The Fe content analysis was carried out using atomic spectroscopy by USEPA 3050 B/3051 A/3052.

Isolation of bacterial strain

1 gram of the sample C1 was added to 9 ml of sterile water and was shaken for about 15 minutes. The soil suspension was used to inoculate the bacteria in a number of different media to determine which favoured its maximum growth. The suspension was serially diluted (in range: 10^{-1} to 10^{-6}) and each dilution was plated (using spread plate method) on various media namely nutrient agar, iron isolating agar, Mueller Hinton Agar, triple sugar iron agar, tryptic soya agar. The plates were incubated aerobically at 37°C overnight at an inverted position.

Morphological characterization of C1

The colonies obtained in iron isolating medium plates were studied for their growth forms, colony morphology. The cellular morphology of Simple stained and Gram stained preparation was determined by bright field microscope.

Determination of optimal growth parameters

The pure culture was used to inoculate the sample in iron isolating broth and incubated overnight at different temperature (4, 25, 37 and 45°C) for 72 hrs. The presence and absence of growth reflected the temperature sensitivity of the bacteria. Bacteria were also grown in different broth having different pH and O.D. was measured to find out the optimum pH.

Biochemical characterization of C1

The different kinds of biochemical tests were performed to characterize C1. The presence of extracellular enzymes like amylase, oxidase, catalase, citrase, etc. was confirmed following the techniques of Nandy et al. (2007). The ability of bacteria to hydrolyze citrate, phenylalanine, tryptophan etc., was studied. Biochemical tests like Indole production, Methyl Red, Voges-Proskauer, Citrate Utilization, Nitrate Reductase, Oxidase, Catalase, Urease, Sulfate Reduction, Starch Hydrolysis, Casein Hydrolysis and Phenylalanine Utilization were studied.

Antibiotic sensitivity test

To check whether the bacteria were resistant to common antibiotics and thus potentially pathogenic the standard disc-agar diffusion method described by Finegold and Martin (1982) for determining the antibiotic susceptibility was used with nutrient agar. The Nutrient agar medium plates were prepared and commercially available antibiotic discs from HiMedia were used. Antibiotics like Ampicillin (10mcg), Azithromycin (15mcg), Linezolid (30mcg), Tetracycline (30mcg), Nitrofurantoin (300mcg), Co-trimoxazole (25mcg), Cefoperazone (105mcg), Streptomycin (10mcg), Augmentin (30mcg) were set on the inoculated agar surface and incubated at 37°C for 24-48 hr. Formation of Zone of Inhibition was observed and its diameter was measured. The sensitivity and resistance profile was determined based on the diameter of the zone of inhibition and evaluation done according to National Committee for Clinical Laboratory Standard's (NCCLS) chart provided with the antibiotic kits by HiMedia.

Determination of metal resistance

In order to determine whether they were tolerant towards other heavy metals and to obtain the minimal inhibitory concentration (MIC) of the metal, the sample was inoculated

in different batches of agar plates. Resistance to heavy metals was determined by an agar dilution method (Washington and Sutter 1980). Plates containing 20ml of agar and different concentrations of metal were poured on the day of the experiments. Each batch had several plates incorporated with different concentrations (0.01mM, 0.05mM, 0.1mM, 0.5mM, 1.0mM, 2.5mM, 5.0mM, 10 mM, 20mM) of a non-volatile salt of the test metal. After overnight incubation at 37°C growth in each plate was observed and compared with other plates. Bacterial resistance was tested against Iron (III), copper, manganese and chromium. The tolerance was measured on the basis of turbidimetric growth measurement within 24-48 h. MIC was determined for each metal visualized by cessation of growth (Yilmaz 2003).

16S rDNA sequencing, bacterial strain identification and phylogenetic analysis

The identification of bacterial sample was sent for 16S rRNA sequencing. Genomic DNA was isolated and analyzed from soil bacteria by the method of Chen and Kuo (1993). Bacterial 16S rDNA was amplified by using the universal bacterial 16S rDNA primers, F (5' - AGA GTT TGA TCC TGG CTC AG - 3') and R (5' - GGT GTT TGA TTG TTA CGA CTT - 3'). PCR was performed and the resulting sequence was sequenced. Forward and reverse DNA sequencing reaction of PCR amplicon was carried out with 8F and 1492R primers using BDT v3.1 Cycle sequencing kit on ABI 3730xl Genetic Analyzer. The 16S rDNA gene sequence was used to carry out BLAST with the nr database of NCBI genbank database. Based on maximum identity score first ten sequences were selected and aligned using multiple alignment software program Clustal W. Distance matrix was generated using RDP database and the phylogenetic tree was constructed using MEGA 4.

RESULTS

Characterization of soil

The pH of the soil from where bacterial strains were collected was found to be 6.20. The colour of the soil was dark reddish brown and the texture was rough. The iron content in mine tailings was found to be 11.69% (Table 1).

Table 1 Concentration of heavy metal (iron) in the soil

ANALYSIS	METHOD	RESULT	LIMIT OF REPORTING	UNIT
Iron (as Fe)	USEPA 3050 B/3051 A/3052	11.69	1.00	%

Isolation of heavy metal resistant bacteria

The colony morphologies were noted and it was seen that growth was observed in all the media. From the independently growing colonies, one strain was randomly selected (on the basis of maximal growth in iron containing media) for further analysis and designated as C1. Further cultivation and maintenance of pure isolates was done in iron isolating medium. Thus iron isolating media acted as a selective media favouring growth of iron resistant bacteria and restricting the growth of contaminant organisms. The soil isolates showed optimum growth at 37 °C (as shown in Table 2) and pH 5.6 (as maximum growth was observed in the iron isolating media).

Table 2 Growth characteristics of the isolate at different temperatures

TEMPERATURE (°C)	4	25	37	45
Growth (+)/ no Growth (-)	-	+	++	-

☐ Morphological and biochemical characterization of C1

The morphological examination of obtained colonies showed the colony to be whitish round translucent colonies. Gram staining showed it to be Gram-positive, short rod, non-motile bacteria. Presence of certain extracellular enzymes like amylase, nitrate reductase, oxidase, citrase was confirmed following the biochemical characterization techniques (Table 2). The strain was found to be positive for starch hydrolysis, casein hydrolysis and hydrogen sulfide.

Table 3

Biochemical characterization of C1 (“+” denotes the enzyme secreting property of the isolate, whereas “-” stands for the absence of enzyme secreting property).

Biochemical Tests	Result
IMVic Test	-
Indole production	-
Methyl Red test	-
Voges Proskauer test	-
Citrate utilization test	++
Urease test	-
Nitrate reductase test	+
Catalase	-
Oxidase	+
Hydrogen sulphide test	++
Starch hydrolysis test	+
Casein hydrolysis test	+
Phenylalanine deaminase test	-
Amylase test	+

☐ Molecular identification and phylogeny of C1

PCR of C1 with 16S rRNA primers yielded a 1500 bp product (Fig. 1). It was subjected to sequencing and BLAST analysis. Blast analysis performed with the sequence and the identity was detected on the basis of the closest neighbour within the existing database showing maximum % of identity. Comparative analysis of the sequences with already available database showed that the strain is close to the members of genus *Arthrobacter* species. The highest sequence similarities of the soil bacterium were found to be with *Arthrobacter* sp. GZK-1(99%).

Lane 1 Lane 2

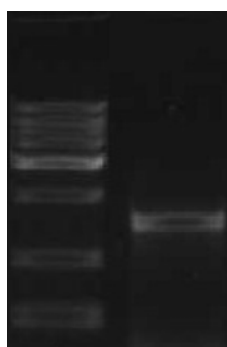


Fig 1. Gel image of 16s rDNA amplification

Phylogenetic analysis

The evolutionary history was inferred using the Neighbor-Joining method (Saitou and Nei, 1987). The bootstrap consensus tree inferred from 500 replicates (Felsenstein, 1985) is taken to represent the evolutionary history of the taxa analyzed (Fig. 2). Branches corresponding to partitions reproduced in less than 50% bootstrap replicates are collapsed. The evolutionary distances were computed using the Kimura 2-parameter method (Kimura, 1980) and are in the units of the number of base substitutions per site. All positions containing gaps and missing data were eliminated from the dataset (Complete deletion option). There were a total of 1326 positions in the final dataset. Phylogenetic analyses were conducted in MEGA4 (Tamura et al., 1987).

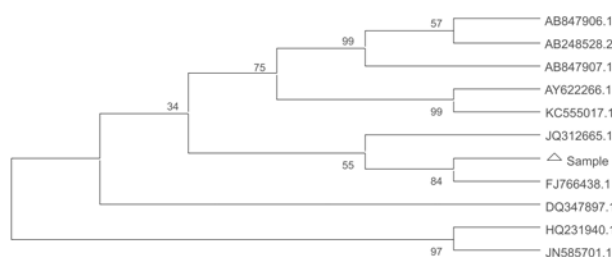


Fig 2. Phylogenetic tree based on 16 rDNA sequences.

The evolutionary distance was inferred using the neighbour-joining method

MIC and antibiotic resistance of C1

Tolerance of the bacterial species was checked towards Cu, Mn, Fe and Cr. While all isolates showed inhibition at 5mM concentration, MIC of the bacterial strain for Mn ranged from 1-2.5mM and for Fe MIC was found to be ranging from 2.5-5mM and Cu and Cr were found to be less toxic. The order of resistance of the bacteria to metals was found to be Fe > Mn > Cu > Cr (Fig. 3).

Several reports indicate metal resistance often holds association with antibiotic resistance probably due to the clustering of these genes in the same plasmid. The antibiotic sensitivity of the isolated strain was tested. Analysis of the disk diffusion plates showed that the strain was sensitive to all the antibiotics used, but with varying Zone of Inhibition as listed in the table. The bacterial strain was found to be moderately to highly tolerant to most of the antibiotics. The bacteria was found to be most resistant towards the antibiotics Nitrofurantoin (FD) and Cefoperazone (CM) whereas most susceptible towards Streptomycin (SM). Hence, the antibiotic sensitivity profile can provide serious insights to explore the molecular mechanisms of resistance and correlation between metal and antibiotic resistance (Fig. 4).

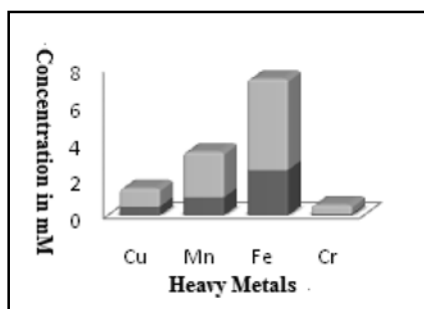


Fig 3. MIC of C1 towards heavy metals

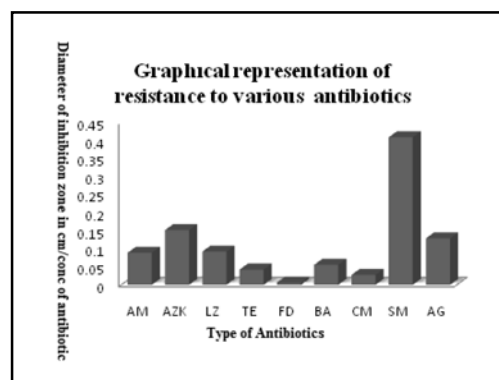


Fig 4. Antibiotic sensitivity profile of C1

DISCUSSION

The genus *Arthrobacter* is an important microbe. It is an important soil microbe and plays several important functions. It is an important microbe known to reduce hexavalent chromium and a common inhabitant of soils rich in industrial mining areas as well as found to be abundant in heavy-metals contaminated area (Hanbo et al., 2004). The widespread occurrence of *Arthrobacter* is due to their nutritional versatility and their pronounced resistance to dessication, long-term starvation and environmental stress (Cacciari, 1987; Boylen, 1973). In our study we were able to isolate this microbe from a condition rich in iron contaminants. On Gram staining we found that *Arthrobacter* is a pleomorphic bacterium which exhibits Gram variability. When cultures are young cells are slender rods whereas they become jointed rods after 1-2 days. After 1-2 days the cells become short, gram-positive rods as found in our studies too. Sequencing carried out with 1500 bp PCR product confirmed it to be *Arthrobacter* sp. having 99% similarity to *Arthrobacter* sp. GZK-1. It showed a high degree of tolerance to iron which could be due to its long exposure as well as adaptation to highly rich iron contaminants. Its ability to chelate iron maybe due to the presence of high-affinity extracellular ferric chelators called siderophores. It also showed high degree of resistance to manganese which is in accordance with other studies. In a study conducted by Dubinina and Zhdanov (1975) they characterized *Siderocapsa eusphaera* belonging to *Arthrobacter* and some species like *A. globiformis* capable of oxidizing iron and manganese. Further on there are previous reports which confirmed the susceptibility of *Arthrobacter* to streptomycin (Dey and Paul, 2012). We need to do more experiments in establishing the role of *Arthrobacteria* in removing the iron content and using it for bioremediation purposes.

ACKNOWLEDGEMENT

We sincerely thank Rev Father Dr. Felix Raj, Principal St. Xavier's College Kolkata and Dr. Arup Kumar Mitra former HOD of department of Microbiology, St. Xavier's College Kolkata. It would not have been possible to complete this paper successfully without his able guidance and support.

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ELECTRONICS

GSM Based Automation and Monitoring System

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Abstract

“GSM based automation and monitoring system” is a multipurpose switching circuit that can be controlled using any mobile device with an active messaging service. The system also has a temperature sensor for monitoring service. This system was implemented keeping in mind the users' requirements to effectively monitor and control any device from a remote location. It is also provided with a safety 'Power Cut Off' feature which is capable of switching off the power to all connected peripherals and warn the users in case of fire (if Temp rises above 50°C). This system is an application of the most widely used mobile communication protocol- the Global System for Mobile communication (GSM). The control system will behave as an embedded system which will alert the users located at a remote site using SMS when a threat is detected. Because of the fact that SMS is an instantaneous mode of communication, the extent of damage can be sufficiently reduced and necessary steps can be taken. If we call the system based on its mobile number (assigned mobile number provided in the system), it will send an SMS back to us.

Keywords: Arduino, GSM modem, SMS, Voice call, Switch, Sensors

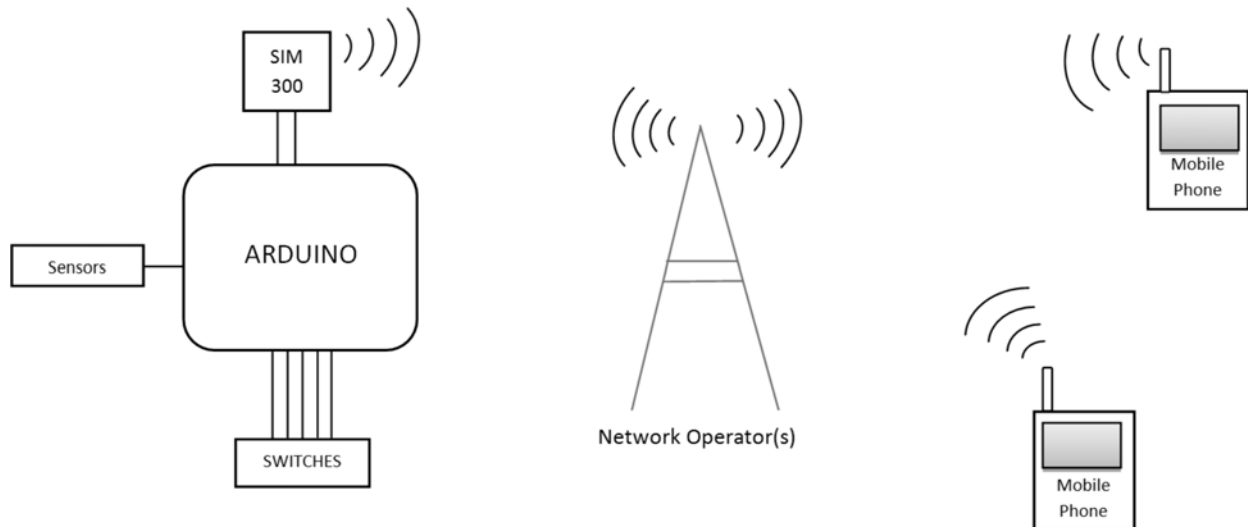
1 Introduction

In this modern era, mobile communication is increasing since it meets most of the challenges in human life. The new service plans in mobile are getting cheaper thus increasing the mobile users. According to ITU 87% of the world population are mobile users and it is 90.47% in India¹¹. Keeping in mind the above issues we have designed a project that is backed up using a GSM network and with the latest technology it is at high demand. With the technical advancement there has been a growing threat of the security of persons'

assets that include movable and immovable objects as well as the intangible services. People are no more stagnant at a single location. With globalization, the requirement of travelling abroad has increased too. So, the necessity of remote management of persons' / organizations' assets is a subject of growing interest. Phone calls and SMS are the most preliminary functions available on any mobile device introduced since 1990s and thus they are the easiest way to communicate across the world.

An overview of the project

GSM based automation and monitoring system consists of a set of switches (Opto-couplers and TRIACs), temperature sensors and a GSM modem connected to Arduino (any model).



The communication can be initiated by either the end users or the system alone. A communication can be initiated for any of the following reason:

- >> SMS from user to update switch status
- >> Call from user to know the status of switches
- >> Abnormal reading recorded by the sensor(s) connected to the system

In all cases a mobile network is the medium of communication via GSM modem. Arduino board communicates with the GSM modem using AT commands.

Circuit components

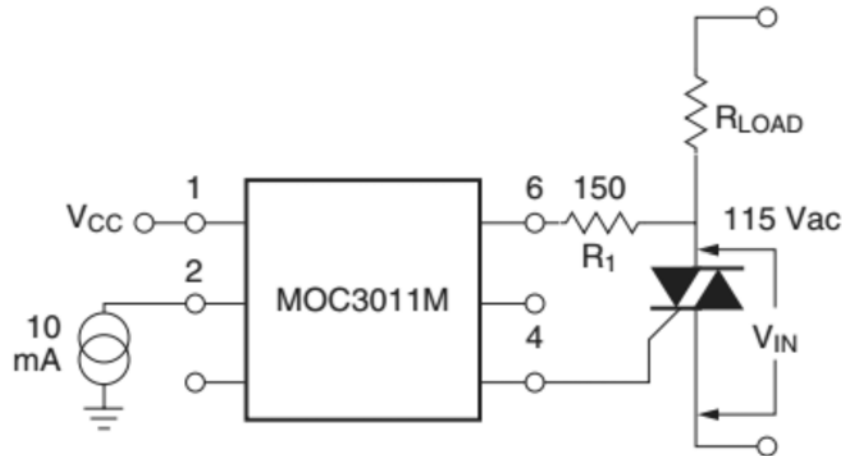
>> **Optocoupler** the MOC3011⁵ Series consists of gallium arsenide infrared emitting diodes, optically coupled to silicon bilateral switch and are designed for applications requiring isolated triac triggering, low-current isolated ac switching, high electrical isolation (to 7500 Vac peak), high detector standoff voltage, small size, and low cost.

>> **TRIACs BT136** is a passivated triacs in a plastic envelope, intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance.

>> **Temperature sensor** The LM35 series are precision integrated-circuit Calibrated Directly in Celsius (Centigrade) temperature sensors, with an output voltage linearly Linear proportional to the Centigrade temperature. (scale factor: Linear + 10mV/ °C)

>> **GSM modem 1** GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. The modem can either

be connected to PC serial port directly or to any microcontroller. It can be used to send and receive SMS or make/receive voice calls. It can also be used in GPRS mode to connect to internet and do many applications for data logging and control. In GPRS mode you can also connect to any remote FTP server and upload files for data logging.



>> **Arduino** is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Board Steps

1 SMS9 from user :

- >> GSM modem informs Arduino that a new TEXT message(SMS) received by the GSM Modem
- >> Arduino reads the message and identifies if the message is intended for the switching circuit
- >> If the message is for switching purpose it updates the switches and removes the message from memory
- >> Upon successfully updating the switches Arduino sends a confirmation SMS to the user

2 Call from user :

- >> GSM board informs Arduino of incoming call along with caller information
- >> Arduino stores the number and drops the call
- >> Arduino sends a status message to the saved number and discards the number

3 Abnormal sensor readings

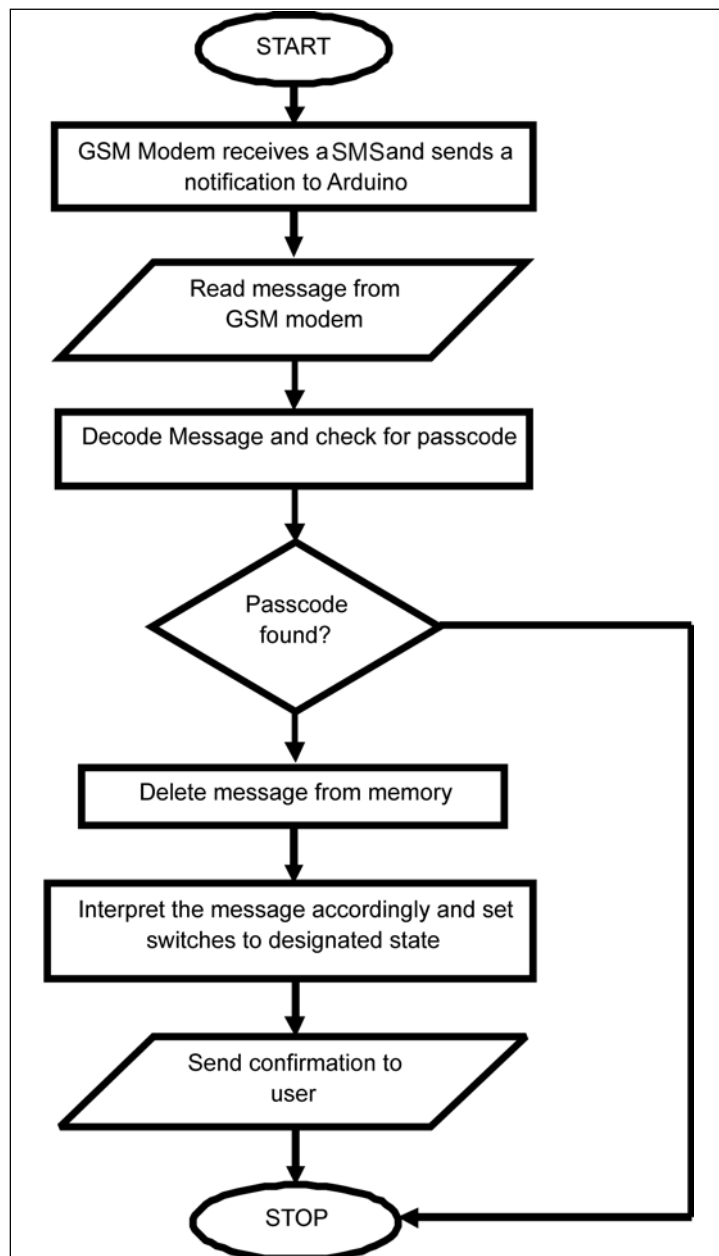
- >> Arduino reads an abnormal reading in a sensor
- >> Arduino cuts off supply to all devices connected to it
- >> Informs the OWNER about abnormal reading details and confirms shutdown of connected devices

Flowchart and coding:

Initializing

```
Serial1.begin(9600);
Serial1.println("AT");
if(Serial1.readString().indexOf("OK")== -1)
{
digitalWrite(GSMError,HIGH);
resetFunc();
}
Serial1.println("AT+CMGF=1");
delay(2000);
Serial1.println("AT+CLIP=1");
```

CASE 1 GSM Modem receives an SMS

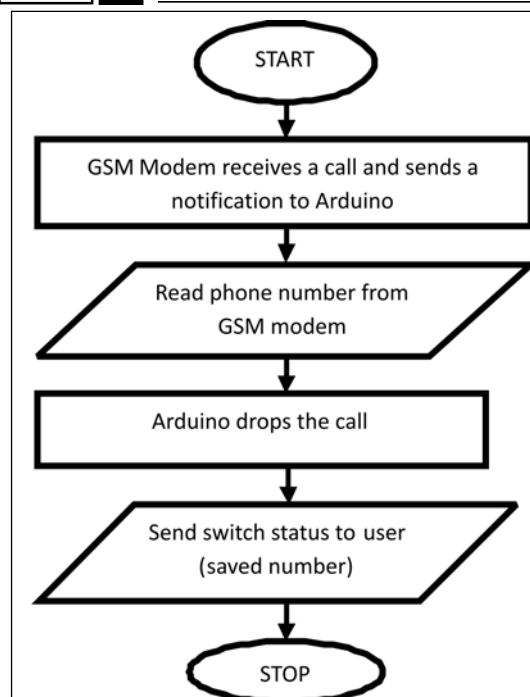


```

if((gsm.indexOf("+CMTI: \SM\"")+1)) //GSM Modem notifies of new message
{
    intstr=gsm.indexOf("SM\"")+4;
    int en=gsm.indexOf('\n',5);
    String st=gsm.substring(str,en);
    Serial1.println("AT+CMGR="+st); //Arduino read message from location st
    while(Serial1.available() <=0);
    gsm=Serial1.readString();
    if((gsm.indexOf("+CMGR")+1))
    {

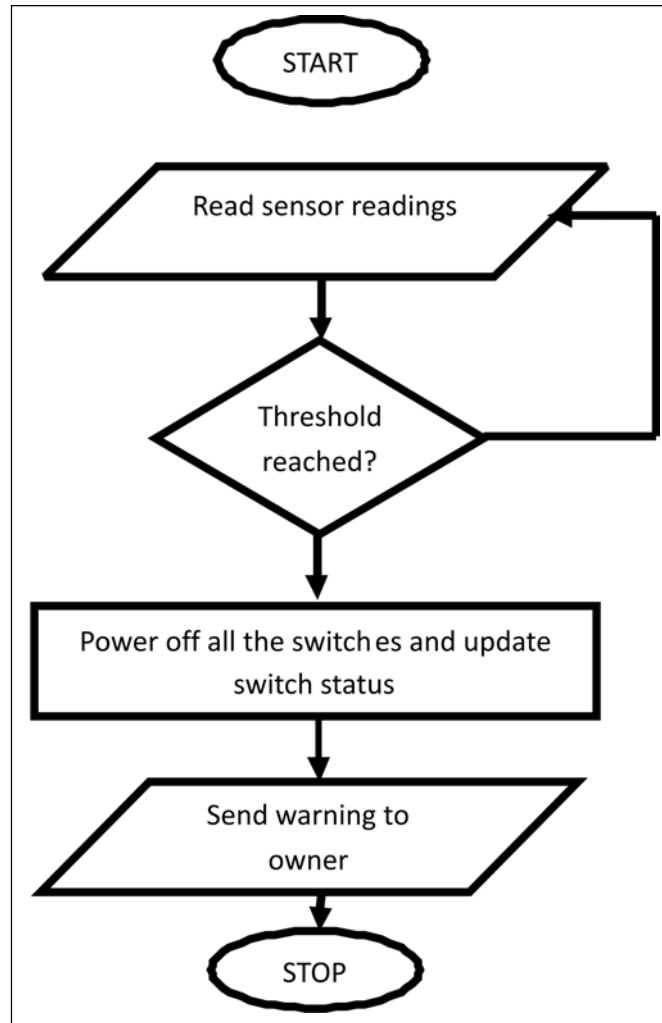
    intstr=gsm.indexOf(",")+2;
    int en=gsm.indexOf('\n',str);
    String sndr=gsm.substring(str,en); // Arduino stores phone number
    str=gsm.lastIndexOf('\n')+3;
    en=gsm.indexOf("OK")-3;
    String msg=gsm.substring(str,en); // Arduino stores message
    if(msg.indexOf("1234")==0) // Passcode checking
    {
        Serial1.println("AT+CMGD="+st); // Delete message
        if(msg.indexOf("SWT1= ON")+1) // Update switches
        {
            Switch_state[0] = 1;
            digitalWrite(23,HIGH);
            k=1;
        }
        else if(msg.indexOf("SWT1= OFF")+1)
        {
            Switch_state[0] = 0;
            digitalWrite(23,LOW);
            k=1;
        }
    }
    if(k)
    GSMSendStatus(sndr); //Send confirmation to user
}
    
```

CASE 2 GSM Modem receives a call



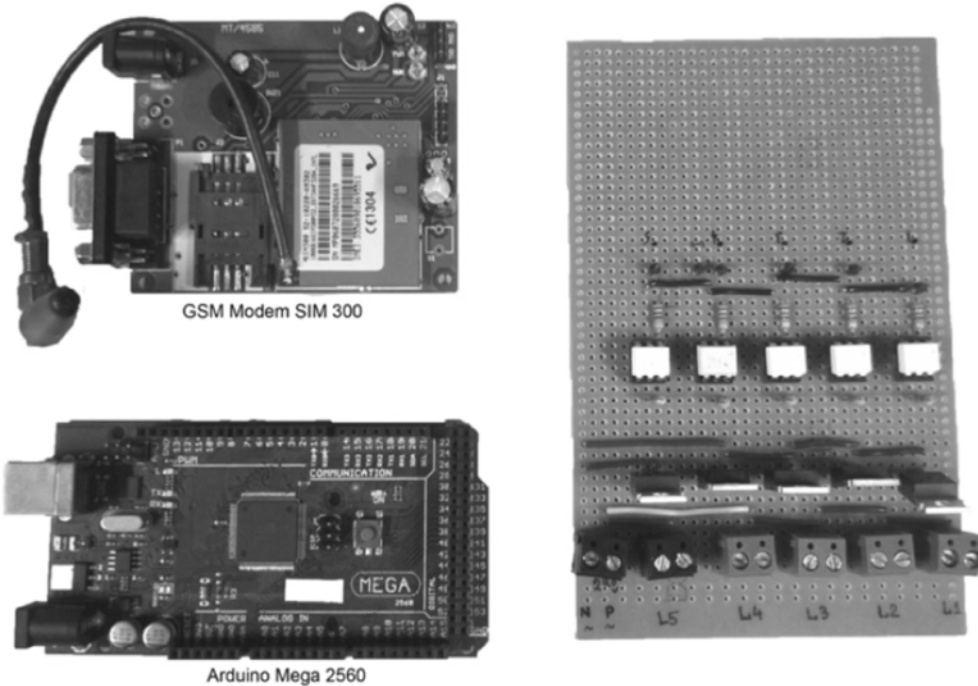

```
if((gsm.indexOf("RING")+1)) //GSM modem notifies Arduino of incoming call
{
  intstr=gsm.indexOf('\')+1;
  int en=gsm.indexOf('\",str);
  String num=gsm.substring(str,en); //read and store caller's phone number
  Serial1.println("ATH;"); // drops the call
  GSMSendStatus(num); //Send status to the caller
}
```

CASE 3 Arduino reads abnormal readings from sensors



```
int temp=analogRead(A15); //read temperature sensor reading
if(temp >102) //threshold value check
{
  if(on)
  shutDown(); //shutdown system if system was running
  else
  sendWarning("0");//else just sends warning
}
```

Note In all the above flowcharts **START** and **STOP** represents waking up from idle state and going to idle state respectively.



2 References

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MICROBIOLOGY

Bioremedial Activity of a Moderate Extremophile from Pharmaceutical Effluent

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Abstract

The bacteria can grow in different environmental conditions and depending on the extremely high pH, temperature, in which they grow, they are termed as extremophiles. The present study was undertaken for microbiological assessment of the effluent, collected from a pharmaceutical company in Kolkata. The physicochemical characteristics determined, where the pH was 6.15 and electrical conductivity of 76.26 mS, indicating multiple ionic interaction. The isolated bacteria showed sensitivity at 25°C against board spectrum antibiotics like Meropenem and Cotrimoxazole. In order to screen a bioremediator; the organism was subjected to a set of biochemical analysis and was observed to has amylase activity. The pectinase activity observed to be strikingly (0.432 U/ml) high, cellulase activity was quantified to be 0.06 U/ ml. The biochemical profile also showed a high PVC degrading ability(13.45%) in 21 days. Finally, the 16s rRNA sequencing was done and the organism was identified to be *Bacillus flexus* strain 61. Thus this bacteria can be considered as a potential multidimensional bioremediator and their growth in any effluent treatment pond will maintain the environmental sustainability.

Keywords: Bioremediator, Cellulase, Physicochemical, electrical conductivity, sustainability

1 Introduction

Industrialization and man's activities have turned out environment to dumping sites for waste materials. In addition, many industries lack proper effluent treatment plants, as a result the untreated wastes are either deposited on the ground. In this study we undertake the microbiological assessment of the effluent is discharged through a pipeline, which leads into a man-made lake that is a pool of the effluent in a farmland. In view of the richness of the effluent in nutrients and the production of some antibiotics like cyclone, glycoseptol, we sought to investigate the sensitivity of isolated bacteria to few antibiotics. In our experiment, by pour plate technique we isolated the bacteria and total colony count was done. We characterized the isolated bacteria on the basis of some physical and biochemical test.

This work describes a gram positive (pH was 6.15 and electrical conductivity of 76.26 mS), potential multidimensional bioremediator having strikingly high enzymatic activity and PVC degrading ability with resistance property to some board spectrum drugs.

MATERIALS AND METHODS

Physical Characterization of pharmaceutical effluent

A certain amount of the effluent sample was physically characterized according to its texture, colour, aroma, pH and electrical conductivity. Physical Characteristics are given in table 1. After physical characterization, the experiment was carried over to detect the presence of any microorganisms and to identify them.

Isolation of the organism from pharmaceutical effluent

The effluent was collected from a pharmaceutical drug manufacturing company. Total colony count of bacteria was done by pour plate method using nutrient agar (peptone: 5g, beef extract: 3g, NaCl: 5g, Agar: 1.8g, distilled water: 100ml) and incubated at 37°C for 24-48 hours. On the nutrient agar plates bacterial colonies were obtained.

Gram characterization of isolated bacteria

After 24 hours incubation nutrient agar plate, a loop full of sample containing bacterial colony smeared on grease free glass slide and stained with crystal violet and saffranine and observed under a compound microscope at 45X magnification. The shape and gram character of the bacterial cells was thus characterized. The results are tabulated as table 2.

Antibiotic sensitivity Test

Antibiotic sensitivity assay was performed with different antibiotics by disc diffusion assay: amoxicillin, meropenem, cefoperazone, linezolid, azithromycin, cotrimoxazole. 100µl of bacterial culture (broth culture) was spread on the agar surface using spread plate technique. Antibiotic discs were placed on the agar plates. All the culture plates were then incubated for 24 hrs at 37°C. After incubation, the diameter of the zone of inhibition, if any, was measured to test the sensitivity of the organisms for that antibiotic.

Biochemical test

With the objective of observing if the isolated bacteria showing antibiotic sensitivity had any enzymatic activities, different biochemical assays were performed which includes: amylase activity, cellulase and pectinase activity.

✓ **Amylase activity** : Amylase test was done to study the starch degrading ability of isolated bacteria. The principal enzyme responsible for starch conversion are alpha-amylase and beta-amylase. Isolated bacterium were streaked on starch agar (Peptone-0.5gm, Beef extract-0.3gm, Starch-0.2 gm, Agar-1.5 gm, water-100ml) plates and incubated at 37°C for 24 hours. On the following day amylase activity was observed.

✓ **Cellulase activity** : The bacteria named as Isolated Colony1 was selected only because of its amylase activity and cellulase assay was performed. With the objective to use a biological agent for removal of industrial cellulosic wastes which have been accumulated in environment, cellulase assay was carried over by using a special screening medium (Carboxymethyl cellulose-0.5g, NaNO₃-0.1g, KH₂PO₄-0.1g, KCl-0.1g, MgSO₄-0.05g, Yeast extract-0.05g, Agar-1.6g, Glucose-0.1g, Distilled water-100ml). After 24 hours incubation the plate was flooded with 0.1% Congo red solution and left undisturbed for 15 mins. To visualize the clear zone formed by cellulase positive strain the plate was destained using 1M NaCl solution. Positive

and better zone producing strain was chosen and continued for enzymatic assay. The activity of cellulase was assayed using DNS method where first 10ml of culture was centrifuged at 5000 rpm for 15 minutes and then 0.2ml culture filtrate was mixed with 1% CMC in a test tube and incubated at 40°C for 30 minutes. The reaction was terminated by adding 3 ml of DNS reagent. The tube was then incubated at 100°C for 15 minutes followed by addition of 1 ml of Rochelle salt solution. The OD (Optical density) was taken at 575nm against blank. One unit of cellulase activity refers to the amount of enzyme that released 1μM of glucose.

- ✓ **Pectinase activity:** 0.1 ml of overnight grown pure culture of the isolated Colony 1 culture was spread on the agar medium plates with pectin gel surface and was incubated at 30°C for 36 hours to obtain the bacterial colonies. These colonies were picked and inoculated in fresh sterile broth and was subsequently incubated at 30°C. After this isolation, the colonies were qualitatively screened for pectinase production by inoculating them in agarified plates of screening media. These plates were incubated at 30°C for 24 hours to observe the zone of clearance as indicator of pectinase production. To identify the enzyme activity of pectinase, 0.1ml of crude enzyme extract collected from the plates of agarified screening media was mixed with the enzyme assay solution. A control was also prepared by using sterile water with the enzyme assay solution. These assay solutions were incubated for 15 mins at room temperature. It was then titrated against 100mM sodium thiosulphate solution to obtain a colourless solution with 1% starch solution indicator. The enzyme activity was then calculated using the following formula:-

$$\text{Unit/ml Enzyme} = \frac{1 \times 100 \times (\text{vol. of blank solution (ml)} - \text{vol. of test solution (ml)}) \times Df}{5 \times 0.1 \times 2}$$

Polyvinyl chloride (PVC) degradation assay : 1 gm PVC powder was dissolved in 10ml of tetrahydrofuran and PVC films were made by coating the upper surface of slide. Slides were kept for 30 mins and then autoclaved. Primary weight (W1) of PVC slab was taken and after 21 days incubation of PVC slab at 37°C on nutrient Agar plate having isolated colony, final weight (W2) was taken. Plastic, a vinyl chloride monomer formed by ethylene with chloride holds a major position in environment pollution. It was reported that 62 bacterial cultures isolated from a range of deteriorated plastic materials were tested for their ability to degrade a particular PVC mix plasticized with di-iso-octylsebacate. With the objective to establish the microbial degradation of PVC, this experiment was performed.

- ✓ **Molecular and 16S rRNA sequence analysis :** DNA was isolated from the culture provided. Its quality was evaluated on 1.2% Agarose Gel, a single band of high-molecular weight DNA has been observed. Fragment of 16S rDNA gene was amplified by PCR from the above isolated DNA. A single discrete PCR amplicon band of 1500 bp was observed when resolved on Agarose Gel (Gel Image-1). The PCR amplicon was purified to remove contaminants. Forward and reverse DNA sequencing reaction of PCR amplicon was carried out with 8F and 1492R primers using BDT v3.1 Cycle sequencing kit on ABI 3730xl Genetic Analyzer. Consensus sequence of **1348bp** 16S rDNA gene was generated from forward and reverse sequence data using aligner software. The 16S rDNA gene sequence was used to carry out BLAST with the NR database of NCBI GenBank database. Based on maximum identity score first ten sequences were selected and aligned using multiple alignment software program Clustal W. Distance matrix was generated using RDP database and the phylogenetic tree was constructed using MEGA 4.

RESULTS

Physical Characterization of pharmaceutical effluent

Physical characteristics of pharmaceutical effluent as shown in the Table I : was observed. The collected pharmaceutical effluent was liquid in nature having no colour and aroma. The pH of the effluent was little bit acidic in nature (around 6.15) and high electrical conductivity indicate impurities.

Isolation of the organism from pharmaceutical effluent

On the basis of gram characterization and morphology the organism was found to be Gram positive rod shaped bacteria. Fig I shows dark violet coloured rod shaped bacteria present in chains form as seen under 45X magnification.

Antibiotic sensitivity

The isolated bacteria being isolated from pharmaceutical effluent showed antibiotic sensitivity against some board spectrum drugs. The results of the antibiotic sensitivity tests is mentioned in Table 3.

Biochemical profiling of bacteria on the basis of some enzymatic assay

The organism isolated from pharmaceutical effluent was inferred to be a starch degrading bacteria having amylase activity, cellulase and pectinase activity as mentioned in Table 4.

PVC degradation by bacteria

The results from the assay showed a PVC degradation of 13.45% in 21 days. Results are given below in Table 5 and degradation ability is explained by Fig IV.

Table 1 Physical Characterization

Properties	Results
Texture	Liquid
Colour	No
Aroma	No
pH	6.15
Electric conductivity	76.26 mS

Table 2 Gram Characterization

Samples	Gram Character	Morphology
Isolated Colony 1	Gram Positive	Short rod shaped.

Table 3 Antibiotic sensitivity

Organism	Antibiotic	Sensitivity	Zone of inhibition			
			D1	D2	D3	Average
Isolated Colony 1 Plate 1	Amoxicillin	Sensitive	3	3	3.1	3.03
	Meropenem	Sensitive	2.6	2.5	2.5	2.53
	Cefoperazome	Sensitive	2.3	2.3	2.4	2.33
Isolated colony 1 Plate 2	Linezolid	Sensitive	3.8	3.5	3.7	3.67
	Azithromycin	Sensitive	2.7	2.7	2.7	2.7
	Cotrimoxazole	Sensitive	4	3.6	4	3.86

Table 4 Biochemical Test

Biochemicla test	Enzyme activity
Amylase activity	(+)
Pectinase	0.432 unit/ml
cellulase	0.06 U/ml.

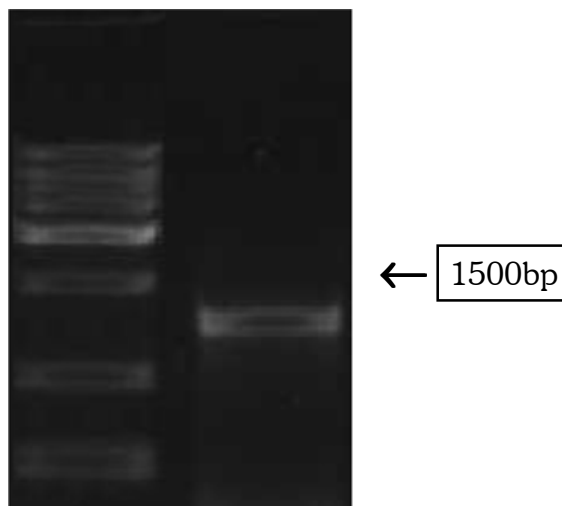
Table 5 PVC degradation

Sample	W1 (gm)	W2 (gm)	% Reduction
Isolated Colony 1	0.203	0.1793	13.45

16s rRNA sequencing

- 1 The culture, which was labeled as Sample was found to be *Bacillus flexus* strain 61 (GenBank Accession Number: KC843403.1) based on nucleotide homology and phylogenetic analysis.
- 2 Information about other close homologs for the microbe can be found from the Alignment.

Gel Image of 16SrDNA amplicon.



Gel Image 1

Lane 1: DNA marker, Lane 2: 16S rDNAmplicon band

Sequence Producing Significant Alignments

Accession	Description	Max Score	Total Score	Query Coverage	E value	Max ident
KC843403.1	<i>Bacillus flexus</i> strain 61	2484	2484	100%	0.0	99%
KC843395.1	<i>Bacillus flexus</i> strain 27	2484	2484	100%	0.0	99%
KC843394.1	<i>Bacillus flexus</i> strain 28	2484	2484	100%	0.0	99%
KC843393.1	<i>Bacillus flexus</i> strain 5	2484	2484	100%	0.0	99%
KC8433591	<i>Bacillus flexus</i> strain 78	2484	2484	100%	0.0	99%
KC951110.1	<i>Bacillus flexus</i> strain LAM-CQ-3	2484	2484	100%	0.0	99%
KC840841.1	<i>Bacillus flexus</i> strain W36	2484	2484	100%	0.0	99%

Accession	Description	Max Score	Total Score	Query Coverage	E value	Max ident
KC602300.1	Bacterium JP72	2484	2484	100%	0.0	99%
KC519396.1	Bacillus flexus strain APT12	2484	2484	100%	0.0	99%
KC178613.1	Bacillus flexus strain DNEB39	2484	2484	100%	0.0	99%
KC519396.1	Bacillus flexus strain APT12	2484	2484	100%	0.0	99%
KC178613.1	Bacillus flexus strain DNEB39	2484	2484	100%	0.0	99%

Distance Matrix

Sample	1		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
KC843403.1	2	0.001		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
KC843395.1	3	0.001	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
KC843394.1	4	0.001	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
KC843393.1	5	0.001	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
KC843359.1	6	0.001	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
KC951110.1	7	0.001	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
KC840841.1	8	0.001	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
KC602300.1	9	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
KC519396.1	10	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
KC178613.1	11	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Phylogenetic Tree

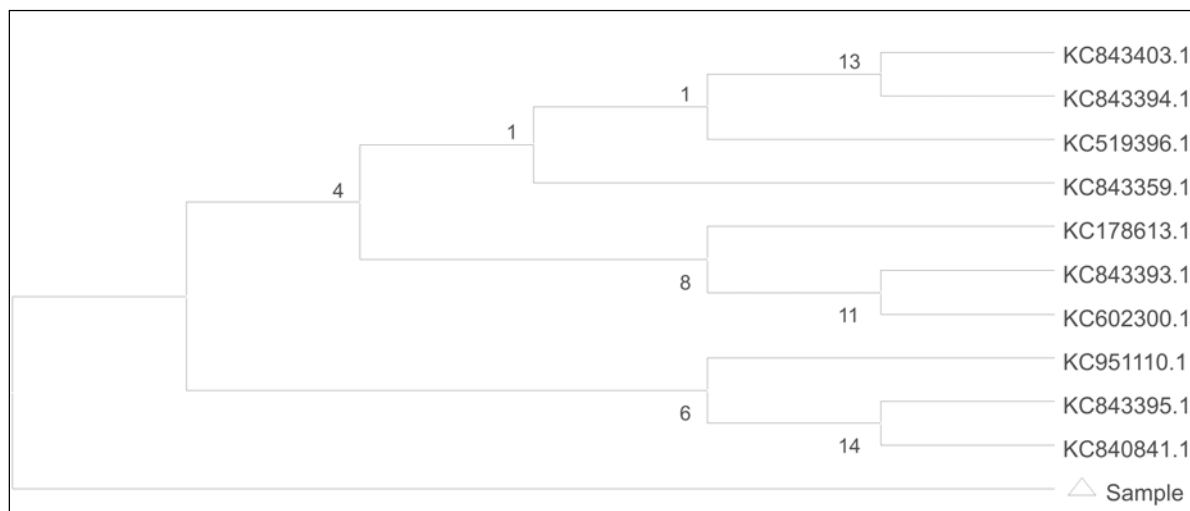


Figure. Evolutionary relationships of 11 taxa : The evolutionary history was inferred using the Neighbor-Joining method [1]. The bootstrap consensus tree inferred from 500 replicates [2] is taken to represent the evolutionary history of the taxa analyzed [2]. Branches corresponding to partitions reproduced in less than 50% bootstrap replicates are collapsed. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (500 replicates) are shown next to the branches [2]. The evolutionary distances were computed using the Kimura 2-parameter method [3] and are in the units of the number of base substitutions

per site. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated from the dataset (Complete deletion option). There were a total of 1348 positions in the final dataset. Phylogenetic analyses were conducted in MEGA4 [4].

Figures

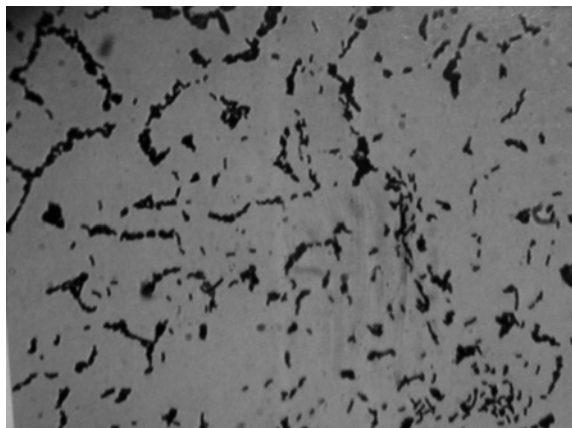


Fig 1. Microscopic view of Gram positive short rod shaped bacteria

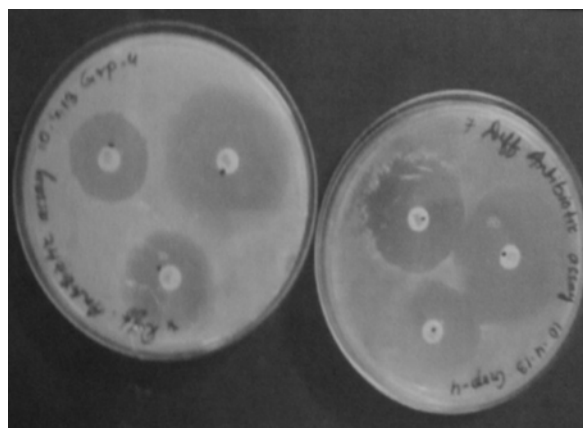


Fig 2. Plates showing antibiotic sensitivity



Fig 3. Starch agar plate showing amylase activity

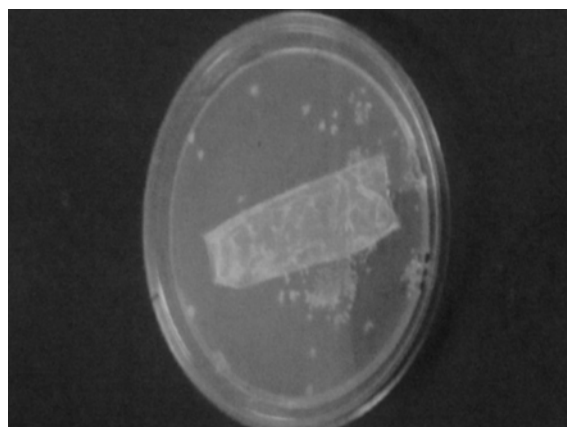


Fig 2. PVC degrading ability

Conclusion

Modernization has caused a lot of mayhem and will cause more when unchecked. In the above study we have isolated bacteria from pharmaceutical waste and this may be the reason for its higher enzyme activities and antibiotic resistance, ensuring its survival in the effluent. Identification of this bacterium by 16s rRNA sequencing revealed it to be *Bacillus flexus* strain 61. Bioremediation using this bacterium is possible in cases with complex substrates due to its biochemical properties.

Acknowledgement

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MANAGEMENT

Linkage Between Job-Employee-Mismatch and Employee turnover intent : A Study

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Abstract

Employees' job-mismatch becomes a major issue in the field of human resource management. Any job-employee mismatch has directly reflected on employee's productivity and that in turn affects organization as well as the economy. This study is an endeavor to examine the nature and extent of the relationship between job-employee mismatches (i.e. salary-skill mismatch, average relation-mismatch with colleagues, locational mismatch and employee's attitudinal mismatch) and employee turnover intent. Based on primary data on IT professionals working in different companies in Kolkata, this study establishes a linear relationship between job-employee mismatches and employee turnover intent. The study reveals that other than salary-skill mismatch, in case of IT professionals, relation-mismatch with colleagues, locational mismatch and attitudinal mismatch are significantly related to employee turnover intent.

Keywords: Job-employee mismatch, salary-skill mismatch, locational mismatch, attitudinal mismatch, relation-mismatch, employee turnover intent.

1 Introduction

The performance of organizations is virtually the reflection of its employees' cumulative performances and that in turn has a direct linkage to the performance of an economy. It is quite evident (Allen & Velden, 2001; Sloane, 2003; Büchel & Mertens, 2004) that employees, in general, perform better in a job-employee matching condition. The degree of fit between individuals' acquired knowledge and skill and the knowledge and skill actually required in their job determine individuals' productivity and earnings in a job. The job-employee mismatches occur when there are disparities between individuals' acquired knowledge and skill and the knowledge and skill required in the job or if there is differences between employee's work attitude and the nature of job. From the economy and the employer's perspective, optimality of a job-employee match reveals on productivity and from the employees perspective, it is the satisfaction associated to a job. Most of the researches

on job-employee mismatches refer to employee's education-job mismatches, i.e. the discrepancy between the employees' attained level education and the level of education required in their jobs (Sicherman, 1991; Halaby, 1994; Borghans and De Grip, 2000). It is revealed by several studies that over-education (i.e. level of education is higher than the requirement in the job) affects employee turnover (Topel, 1986; Hersch, 1991), occupational choice (Viscusi, 1979) and job satisfaction (Tsang and Levin, 1985). In this perspective some studies (Dolton & Silles 2008; Duncan & Hoffman 1981; Lamo & Messina 2010; McGuinness & Sloane 2011; Van der Meer 2006) revealed that over- (under-) educated employees earn more (less) than the adequately educated employees and this according to human capital theory implies that over- (under-) education increases (decreases) employees' productivity. Sicherman (1991) observed that apart from the attained level of education, job characteristics also determined worker's productivity. In fact, both the individual human capital and job characteristics are related to wages but according to the job-competition theory (Thurow, 1975) wages are determined primarily by the job characteristics and not by individual productivity.

The crux of problem in the underdeveloped or developing countries is that the rising unemployment rate in those economies has decreased options for the individuals to get job of their own choice. The unemployed individuals desperately try to get a job without thinking whether the job fits to his or her qualification, skill and temperament or not. Therefore, after getting employment, there is high probability of job-employee mismatch and that is happening in reality in greater number. This job-employee mismatch produces role conflict, role overload, job stress, i.e. all the correlates of employee's job satisfaction and that enhance employee turnover intent. When the voluntary employee turnover is restricted by the lack of alternative job opportunities in the economy, then employees' dissatisfaction is reflected on his or her poor performance and that in turn would have negative affect on organization's productivity. This job-employee mismatch is a clear indication of underutilization resources.

Under the present economic globalization, firms and organizations are facing hypercompetitive market rivalries and in order to achieve or maintain competitive advantage in the market they are mostly relied on their own human resources. In such a situation, the job-employee mismatches have actually jeopardized organization's work culture and that ultimately weaken the overall economic potentials of the employees, organizations and the overall economy. Leuven and Oosterbeek (2011) pointed out that among other things, the conceptualization of over-education and job-mismatch has not been properly addressed. However, it is fact that the gravity of this problem can never be denied, but no serious study has been done so far in the developing economies, like India. The present study is an endeavor to unveil the linkages between job-employee mismatches with respect to some job related issues, other than employee's job-education mismatch, and employee's turnover intent.

2 Theoretical concept

To understand the linkage between job-employee mismatch and employee turnover intent, it would be of great help to have a theoretical concept of the linkages between job-employee mismatch and employee's productivity, performance of the organization and the performance of the economy.

Let,

E_i^P = Performance of the i^{th} economy;

E_{ij}^P = Performance of the j^{th} firm of the i^{th} economy;

Em_{ijk}^p = performance of the k^{th} employee of the j^{th} firm in the i^{th} economy;

J_k^w = Extent of employee's job-work matches

Now,

$$Em_{ijk}^p = f(j_k^w); \frac{dEm_{ijk}^p}{dj_k^w} > 0 \quad (1)$$

$$F_{ij}^p = g(\sum_{k=1} Em_{ijk}^p); \frac{dF_{ij}^p}{dEm_{ijk}^p} > 0 \quad (2)$$

$$E_i^p = G(\sum_{j=1} F_{ij}^p); \frac{dE_i^p}{dF_{ij}^p} > 0 \quad (3)$$

Therefore,

$$E_i^p = G\left[g\left\{f\left(j_k^w\right)\right\}\right] \text{ and} \quad (4)$$

Again,

There are various components of job-employee mismatches. Such as, education-job match (Ed_m^j), job-location mismatch, worker-Job characteristics mismatch, Employee-colleague mismatch, job-remuneration mismatch, Job-work schedule mismatch, etc.

if, donotes the Job-mismatches of the k^{th} employee then

$$J_k^{em} = F(Ed_m^j, L_m^j, W_m^{jc}, Em_m^c, J_m^r, J_m^{ws}, \dots) \quad (5)$$

...

The employee's job mismatch generates employee's dissatisfaction (Ej_k^{ds}) and the level of job dissatisfaction is the sum of job-employee mismatches, i.e.

(6)

Higher level of job dissatisfaction (EJ_k^{ds}) generates role conflict, role overload, job stress, and that in turn would motivate employee to search for an alternative i.e. all the correlates of employee's job dissatisfaction would therefore enhance employee turnover intent.

Assuming a linear relationship (on the basis of correlation matrix) between job-employee mismatches and employee turnover intent then the model equation becomes

(7)

Where Y = employee turnover intent and ε is residual error.

3 Data and Methodology

The resent study is based on primary data, collected through canvassing pre-ordained questionnaire among 460 Information Technology (IT) professionals working in different IT companies around Kolkata. The respondents were asked multidimensional questions to assess their attitude towards life and work, their number of company changes and the reasons behind their leaving companies, employees' various job-mismatches etc. In the present study

only the relevant information are used. Out of 460 respondents 420 respondents have found to have change job at once (number of change of jobs ranges between is 1 to 6). The present study is confined only on 420 respondents who have at least change one company.

Here I tried to examine the nature and extent of some of the job-employee mismatches (i.e. salary-skill mismatch, mismatch in relation with colleagues, locational mismatch and attitudinal mismatch) and their relationship with employee's turnover intent. Employee's number of company changes, i.e. employee's frequency of company changes is taken as a proxy of his or her turnover intent. To assess the relationship between employee's turnover intent and employee's job-mismatches I have calculated a bi-variate correlation matrix and on the basis of that I tried to fit a linear multivariate regression model.

Table 1 Descriptive Statistics

Job-Employee Mismatches		Male				Female				Overall Total
		Age Group				Age Group				
		Below 30	30-35	Above 35	Total	Below 30	30-35	Above 35	Total	
Attitude	HPWL	59	69	45	173	37	21	14	72	245
	HPSL	45	42	41	128	20	22	5	47	175
	Total	104	111	86	301	57	43	19	119	420
Salary-Skill Mismatches	Yes	57	60	43	160	30	21	9	60	220
	No	47	51	43	141	27	22	10	59	200
	Total	104	111	86	301	57	43	19	119	420
Locational Mismatches	Yes	42	45	35	122	16	13	7	36	158
	No	62	66	51	179	41	30	12	83	262
	Total	104	111	86	301	57	43	19	119	420
Intra Company-Employee Relationship Mismatches	Yes	101	100	75	276	44	38	13	95	371
	No	3	11	11	25	13	5	6	24	49
	Total	104	111	86	301	57	43	19	119	420

Source: Primary Survey.

Note (i) HPWL = Highest Priority given to Work Life; (ii) HPSL = Highest Priority given to Social Life

4 Model

Dependent variable

E_{NCC} : Employee's number of company changes.

In this model employee's number of company changes (E_{NCC}) is considered as a proxy of his or her turnover intent.

Independent variable

1 SS_{Mm} : Salary-skill mismatch

Hypothesis: An individual employee always tries to get proper price of his or her skill/ talent. Salary-skill mismatch would generate job dissatisfaction. Higher degree salary-skill mismatch would insist employees to search for proper salary-skill match elsewhere. Hence, higher degree of salary-skill mismatch will enhance employee's turnover intent. Therefore, SS_{Mm} and E_{NCC} would be positively related.

2/ AR_{Mm} : Average relation mismatch with colleagues

Hypothesis: Employee's relation with other colleagues (i.e. relation with his or her co-workers, senior and junior workers) is an important constituent of work environment. Higher matching would reduce employee's turnover intent. In other words lower matching would increase turnover intent. Therefore, a negative relationship would exist between AR_{Mm} and E_{NCC} .

3/ LO_{Mm} : Locational mismatch

Hypothesis: Employees always search an organization where there is locational advantage. Therefore, when other things remain unchanged, more disadvantageous location always insist an employee to change the work place. Therefore, LA_{Mm} and E_{NCC} would be positively related. But when the degree of other mismatches is significantly high with relatively low degree of locational mismatch then this lower locational mismatch may act as a turnover reducing factor.

4/ AT_{Mm} : Attitudinal mismatch

Hypothesis: Individual attitude is a cognitive factor that affects his or her work performance. The respondents are classified according to their own assessment on attitudinal priority into four categories, e.g. 1 = higher priority to work life (HPWL); 2 = moderate priority to work life; 3 = moderate priority to social life and 4 = higher priority to social life (HPSL). Thus, value 1 is assign to the employees who are much concerned about this or her professional career and for any better available opportunity they would like to avail that. Therefore the expected relationship between AT_{Mm} and E_{NCC} would be negative.

In order to identify the relationship between E_{NCC} and the independent variables (mismatches, i.e. SS_{Mm} , LO_{Mm} , AR_{Mm} and AT_{Mm}) a correlation matrix have been calculated (see below).

Table 2 Correlation Matrix

	E_{NCC}	SS_{Mm}	AT_{Mm}	LO_{Mm}	AR_{Mm}
E_{NCC}	1				
SS_{Mm}	0.016	1			
AT_{Mm}	- 0.267**	0.031	1		
LO_{Mm}	0.139**	- 0.064	0.019	1	
AR_{Mm}	0.007	0.054	- 0.211**	0.044	1

Note ** Significant at the 0.01 level and * significant at the 0.05 level

On the basis of the correlation matrix we assume a linear relationship between E_{NCC} and the independent variables (mismatches) and the model equation becomes

$$Y(E_{NCC}) = \alpha + \beta_1(SS_{Mm}) + \beta_2(AT_{Mm}) + \beta_3(LO_{Mm}) + \beta_4(AR_{Mm}) + \varepsilon$$

The estimated equation is

$$Y(E_{NCC}) = 2.347 + 0.070SS_{Mm} - 0.311AT_{Mm} + 0.209LO_{Mm} + 0.056AR_{Mm}$$

(6.77**) (0.66) (-5.91**) (3.17*) (-1.20)

(The figures in the parenthesis represent t values and **. Significant at the 0.01 level and * significant at the 0.10 level)

5 Discussion

Perfect job-employee matches can be considered as a state where the employee is freely and enthusiastically exerts his or her full potential and thereby attains optimum productivity. But the probability of a state of cent percent job-employee matches is very rare. However, certain degree of job-employee mismatches are always exists. But if the degree of mismatches exceeded the employee specific acceptance limit it would generate job dissatisfaction. The effects of job dissatisfaction are role conflict, role overload, job stress etc. will severely affect employees' productive performances and that in turn would ultimately motivate employee to search for an alternative. It is evident from the bi-variate correlation matrix that two (i.e. locational mismatch and attitudinal mismatch) out of four dimensions of job-employees mismatches are significantly correlated to employees' turnover intent. Only salary-skill mismatch and average relation with other employees appear to be insignificantly related to employees' turnover intent. The positive relation between salary-skill mismatch and turnover intent implies that higher degree of salary-skill match will increase employee's turnover intent, i.e. greater degree of salary-skill mismatch leads to higher possibility of employee attrition. The insignificant relation appears here may be due to that the degree of salary-skill mismatches are not much to be counted in case of IT professionals. It is to be noted here that all our hypothetical relationships between job-employee mismatches and employee turnover intent have appeared to be accepted.

It also appears that the overall model equation appears to be highly significant and the only salary-skill mismatch (SS_{Mm}) appears to be insignificant. The intercept (2.347), the coefficients of locational mismatch (LO_{Mm}) and attitudinal mismatch (AT_{Mm}) are significant at 0.001 levels but the positive relation between mismatch with the colleagues (AR_{Mm}) and employee turnover intent appears to be insignificant. This may be due to IT employees are less bother with such relationship. The positive relation between LO_{Mm} and E_{NCC} implies that higher locational mismatch will enhance the probability of the employees to leave the company. Similarly, negative relation between AT_{Mm} and E_{NCC} implies employees giving high priority to work life have higher tendency to leave company. Employees' relation with their fellow colleagues (AR_{Mm}) appears to be one of employee turnover determining factors. Higher mismatch with the fellow colleagues implies the employees' degree of mismatch with the company's work environment and that will insist the employee to leave company.

6 Concluding remarks

Job-employee mismatch becomes a serious issue, especially for the high valued employees. In job-employee mismatches, employees are in general become dissatisfied with their job and psychologically demand for better matching alternative job. The outcome of job-employee mismatches depending on availability of alternative jobs. In a situation where alternative job opportunities exist and there is job-employee mismatch then (a) any offer from other similar

organizations may appear to the employees as an alternative for better job match possibilities and they will try to switch over; (b) in some cases it may happen that the employee tries to compensate his or her job-mismatches for higher-salary, higher-portfolio or higher company-brand-name. In any case high valued employee turnover nevertheless would be high cost to the concerned organization. On the other, if there is no alternative job opportunity, in that case job-mismatched employees would become reluctant to exert his or her full work potential to assigned work, may enhance absenteeism, employee's productivity will fall and above all organization's work culture would be severely affected.

There are various dimensional issues on job-employee mismatches but in this study I have dealt with only four issues and that is the limitation of this study. However, this study clearly unveils the relationship between job-employee mismatches and employee turnover intent and emphasizing on framing proper and flexible work schedule, establishing friendly employee-colleague relationship and a cooperative work environment. All these will revitalize employees' work efficiency and increase productivity and that in turn will enhance organization's performance as well as the performance of the economy.

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HISTORY

Disease and Women : A New Quest For Identity - In The Light Of Vernacular Writings (1870-1930)

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The purpose of this paper is to highlight the writings of the educated Bengali women on health with special emphasis on disease in the journals meant for them during the last half of the 19th and the first two decades of the 20th century. The source material for this paper is gathered from vernacular literature mainly published in three contemporary journals, *Bamabodhini*, *Bharati* and *SwasthyaSamachar*.

The problems as faced by the present researcher while pursuing an extensive study on this subject are multiple.

Firstly, it is not always possible to find out the true identity of the authors, as many men used to write in the name of a woman. More importantly, in many writings, the name of the writer was not given.

Secondly, in the *Samsad Bangla Charitabidhan* (an encyclopedia of the eminent personalities of Bengal) very few details have been given. Even not for everyone.

Thirdly, it is also difficult to trace the response of the society to these writings as in the form of feedbacks or reviews of such writings are also unavailable.

Fourthly, the writers repeatedly made a link between divinity and science and emphasized on the importance of destiny. Perhaps this stance was inappropriate and such removed from reality.

Fifthly, the language was often ornamented and the expressions were melodramatic. All these prevent to take out the gist of such kind of writings.

Finally, the positive impact of western education and the moral support of their male counterparts perhaps encouraged these women to raise their voice in favor of spreading health awareness. But they were few in number. From this perspective, these attempts should be taken as a scattered venture in its experimental stage.

In 1872 (B.S.1278) an article was published in the 94th edition of the *Bamabodhini Patrika*, where the author wrote a poem on the digestive system of our body. In this poem, the mechanism of digestion was explained along with the formation of excreta.¹ In another article, published in the same journal, the functioning of vocal cord was described with a religious appraisal.²

The health of infants was one of the prime concerns of these writings. In one article, namely, “*Matrishikshahoitendrito*” or “Lessons for Mothers”, the writer explained various symptoms of illness which make a child cry and uncomfortable.³

In 1913 (B.S.1319), Sri Charumati Devi wrote on “Infantile mortality and mother’s responsibility” in *Bamabodhini*. She highlighted the wretched condition of the confinement room during delivery, which made the new-borne prone to ailments. Even they were saved by the grace of God; still the dearth of proper shelter, pure air and nutritious food crippled them to have a normal life. Numerous middle and upper class families of Bengal hardly bothered about sanitation and personal cleanliness. They were unaware of the importance of pure water and air. All these led to frequent occurrence of various diseases as the author opined.⁴

Furthermore, *Charumati* laid stress on women’s education which was the key to awareness and emancipation. She appealed to the male members of the society to take care of their female counterparts. The poor status of the house-wives, and the malnourished, badly clothed infants perhaps exhibited one of the glaring features of the then Hindu society based on gender discrimination.⁵

The importance of breast feeding and use of filtered water was highlighted to spread a general awareness with regard to child care. To develop the brain functioning and senses of the infants, a series of articles were regularly published in *Bamabodhini* with the title of “*Shishujibon o kinder garden*” (“*Child life and kinder garden*”). In 1914, in the Bengali month of Jaistha, it was written, “*a woolen ball should be hanged on the top of the baby cot. It will help the new borne to have an idea on the shape of an object. If the mother sings a song and moves the ball slowly according to the rhythm, then the baby develops sense of speed and knowledge of vocabulary.*”⁶

A similar type of essay was published in the journal *Bharati* in 1889 by Swarnakumari Devi. The name of her piece was “*Mesmerism*”. She made a link between hallucination and nervous system, and cited one Mayers. According to whom, soul can function independently. It goes beyond of senses, pain and diseases. The correlation between earthly objects and soul is a ‘*passing accident.*’⁷

In 1875, an article, namely, ‘*The Opinion of the Famous Philosopher, Herbert Spencer, on Women*’ was published in *Bamabodhini*. It was the Bengali translation of the 15th chapter of ‘*The Study of Sociology*’ (pp.373-381) as mentioned by the author. The essay emphasized on the fact that, the basic metabolism rate of women is less than men, for which they exhale minimal Carbonic Acid. It proves women’s inability to perform rigorous physical activities like their male counterparts. More importantly, the growth of ‘*Nervomascular system*’ in female is comparatively less as the medical science has shown.⁸ Perhaps the aim of this article was to enlighten the readers regarding female anatomy in accordance with the western medical science. Several home-made remedies for the ailments like asthma, stomach infection, cough and cold, obesity, amebiasis, diabetes, pyle’s, vomiting, venereal disease and many more were described in *Bamabodhini* to make the women aware and to take precautions.⁹

Even the remedies for malaria were described, though the scientific explanation of all these was not known. Apart from these home-made remedies, certain homeopathic and allopathic medicines with their specific doses were also prescribed. These were compound chalk powder with opium for acidity, sentunine or bon bon with purgative for deworming, sodibicurb, galic acid and dovers powder for amibiasis with blood, sulphate of zinc, extract of beledona and water for whooping cough etc.

According to these literature, the leaf of the plant *Kuksima* helps to cure malaria. The roots of *Tepari* fruit can be used as an amulet, and the patient should wear it on Saturday and Tuesday on his right arm for three days to get rid from the ailment. Lastly, the plantation of Sun-flower tree prevents a house from the mosquitoes.¹⁰

The authors also wrote in favor of *Āyurveda*, the traditional Hindu medical system. It was stated, 'If an ailment develops in a particular environment, then it is better to find out its remedy only in that place. It is absurd to treat a patient in Bengal with the medicine of Lapland...' ¹¹

In one advertisement, published in *Bamabodhini* in 1875, Srimati Khantamani Devi recommended one medicine by Dr. Bhuvan Mohan Sarkar on infertility. She suggested this medicine to all those women who were suffering from childlessness.¹² It was definitely an attempt to market the product. But it also provided a platform where the women could express their opinions.

In *Mitraprakash* (circulated from Dhaka), an article was published in 1872 on the book review of *Kabita Manjari*, a collection of poems by Srimati Basantakumari. She was the wife of a landlord, and had already earned fame as a poet. During her prolonged illness she wrote many soulful poems which were later compiled in the *Kabita Manjari*. From this piece of literature it is evident that in colonial Bengal, the infrastructure for treatment was pathetic and full of confusions. Even the affluent people could not get proper treatment and spent money like water. *Basantakumari* expressed her frustration and depression through her writings and prayed to God for her speedy recovery.¹³

Sri Laxmimoni wrote a poem on the Burdwan fever, or a special kind of ailment which once took the form of an epidemic in the district of Burdwan. She wrote this in *Bamabodhini*, one of the leading journals for the women of Bengal in 1871.¹⁴ It was a simple poem describing the fatal effects of the disease. The language was not ornamented, though heart-touching. In the beginning, the poet addressed Almighty to look after the miserable condition of the natives due to the Burdwan fever. She described how the poor people irrespective of their age and physical strength became victims of the disease. They were so helpless that they could not afford to buy allopathic or western medicine. The indigenous medicine proved to be ineffective which also accelerated the pace of the crisis.¹⁵ She highlighted the dearth of western medicine or 'mixture', which was the only remedy in this case.¹⁶ The numerous deaths deeply saddened her, who saw this ailment as a demon. According to Laxmimoni, the demon of Burdwan fever tried to snatch the lives of many, even the rich people were not being able to escape.¹⁷

Being a non-medical person, it was not possible for Laxmimoni to detect the symptoms. But she emphasized on the loss of appetite and enlargement of the spleen, the two major side effects of the Burdwan fever.¹⁸ She categorically described the immense agonies of the mothers and wives, whose children and husbands were fighting against the disease. Even the aged people also became victims of this deadly ailment.¹⁹ The author appealed to God to save these poor and destitute. More importantly, often the western medicine became fruitless and failed to give any relief. At this specific juncture of the poem, the author in the last stanza again begged to Almighty for His pity and kindness.²⁰

Prabhabati Devi Saraswati, a famous Bengali novelist, in 1924 wrote an article in the *Swasthya Samachar Patrika* on malaria. The title of her piece was 'Malaria in Bengal', or 'Banglai Malaria'.²¹ In this article she had taken an attempt to analysis the reasons behind malaria. She was aware about the deadly effects of the ailment which devastated village after villages.

According to her, perhaps it was a die-hard battle between men and malaria, where most of the time malaria won. It was her belief that previously malaria was not rampant in Bengal; even before 30 or 40 years from her time.²² Here she did not blame anybody. But Prabhabati through her writing tried to investigate the actual cause, where the cultivated indifference of the British Raj and the unreceptive mentality of the contemporary society became metaphors. Being a novelist, she had a flair for writing. Her language was lucid and the entire piece seemed to be informative. For example, Prabhabati mentioned about a village in the Jessore district, which was once inhabited by many rich families. This prosperous village became one of the victims of malaria and deserted by the villagers. Perhaps she went to this village and witnessed the ruins. To describe the only source of potable water for the villagers, she wrote, *'...the river, nabhanga, is thoroughly filled with water-hyacinth and utilized by the villagers for the jute cultivation. As a result of this, the water becomes reddish and foul smelling. It also transforms into a breeding ground for mosquitoes...'*²³

After describing the wretched condition of rural Bengal, the author held responsible the native society, particularly their callous attitude for all these. She wrote that, these people due to their lack of awareness were moving forward to the path of death and destruction, which should be prevented. These people always had a tendency to blame their destiny and never showed willingness to find out the solution.²⁴

According to the author, the British colonial dominance made the natives weak-minded and spine-less, failed to win over the political and social inequalities. Furthermore, they had only learnt to maintain a profound faith in their destiny and were perhaps destined to face peril and perish.²⁵

Prabhabati's writings reveal her consciousness about the contemporary social situation. In describing the pitiful condition of the villages, she pointed out towards the callousness and the felling fatality among the dwellers. In doing so she was depicting a sensitive mind, and representing herself as a confident educated woman.

She was highly aware of the insanitary condition of rural Bengal and highlighted how the natives contaminated potable water, polluted the environment and causing health hazards like malaria. Prabhabati tried to portray the basic characteristics of the Bengali villagers, who were usually narrow-minded, bounded with irrational religious customs and superstitions, and tremendously interested to get involved in litigations. Their jealous attitude was a cause of their backwardness as she thought.

The author vividly described how the natives due to their ignorance became victims of malaria. She emphasized on the need of basic awareness which should be communicated to both educated and uneducated masses of Bengal. The rural people of Bengal never tried to understand the intimate relation between mosquito and malaria and often ridiculed on this. Prabhabati through her writing highlighted this particular issue and appealed to the natives to become conscious.

The importance of the western education also constituted as an imperative component of her article. She firmly stated,

*"It is our duty to cope up with the existing situation. We must learn English to become self-sufficient, even go abroad for higher education. There is no restriction in the traditional Hindu religious texts about all these. These are the creations of the few bigoted illiterate Hindus who are against any kind of reform. The acceptance of western education does not mean the transformation of a Bengali native into a 'Saheb' or foreigner; ..."*²⁶

This particular mentality of the author was also evident in her ideas about health and hygiene. She gave a call to the young generation to make the environment healthy and pollution free. More importantly, she appealed to the women of Bengal to become health conscious and protect their families from the ailments. She made a plea to all *'to abscond from all the practices which are unhealthy and to have a normal life style.'*²⁷

A certain section of Muslim women in Bengal also became health conscious during the first half of the twentieth century. Amongst them, Faizunnessa Chowdhury was a pioneer. Her autobiographical novel *'Rup Jalal'* was an emblem of her feminist far-reaching thoughts and revolutionary ideas. She had understood the deplorable condition of Muslim women, whose health never became a serious concern for the male members of the society. After analyzing all these she established a zenana hospital or a hospital for women in Kumilla district of the then undivided Bengal.²⁸

Another Muslim lady, Begum Rokeya Sakhawat Hossain through her writings had won the heart of millions and spread the message of Muslim women's emancipation. She emphasized on the well-being of Muslim women and gave instructions to stay healthy. Rokeya was aware of the growing rate of infantile mortality, and appealed both to the pregnant and lactating mothers to respect the age-old beliefs along with the western line of treatment. She tried to highlight the scientific aspects of Islam, which had no contradiction with western medical science.²⁹

1 Conclusion

The above-mentioned ladies through their writings tried to create an environment of health awareness. They wrote about anatomy, child psychology, general child care, pregnancy, and lactation, the importance of *Āyurveda*, the effectiveness of home-made medicinal remedies, and the description of different diseases.

Perhaps these writings were the examples of their enlightened mind, with the aspiration of emancipation. They severely criticized the patriarchal society for its unreceptive mentality and callous attitude and also the Government for its cultivated indifference. They cordially welcomed the western method of prenatal and post-natal child caring, which was educative and scientific. On the other, respect for age-old customs, and indigenous medical system often formulated the core of their articles.

Probably the basic purpose behind these writings and objective of these women writers were to bring about awareness of health and hygiene in their household. These women aimed at improvement of health conditions through their writings. Regarding their identities, there is a controversy which I have mentioned earlier, as there was a trend to write with the name of a female. But most of these articles were published in the journals like *Bharati* and *Bamabodhini*, which were meant for the women of Bengal. More importantly, their opinions were used to market medicines, mostly related to fertility, can be considered as a step towards modernity and freedom of speech with the approval of the contemporary society.

The writings of Prabhavati and Laxmimonideserve special mention. Laxmimoni's poem on malaria is an example of how a self-taught and home-bound woman felt the necessity of raising her voice against the prevailing malady. It also tells us about the concern of these women to social problems, the awareness of the general poverty all around. In questioning the circumstances, Laxmimoni was perhaps raising a point against the non-performance of the colonial Government. This point is not explicitly expressed. It is for the readers to discern the implied meaning.

Perhaps the main objective of the authors was to enlighten the readers regarding the existing condition of health and hygiene, where malaria and Burdwan fever played the role of metaphors. But these works fueled nationalism, where an ardent desire for self-rule was hidden, particularly, in Prabhabati's piece. On the other, Laxmimoni focused on the inexhaustible poverty of the villagers' which was furthermore crystallized by the colonial indifference.

These ladies through their writings tried to create a public forum especially amongst the women of Bengal. It is true that, they were not the trend-setters. But their works were the testimonies of the inquisitive and enlightened Bengali mind, leading for a quest of identity.

Some of these women writers through their writings, not only projected the rules for child care, also portrayed the notion of a strong motherhood, inclined to protect her progeny. Jasodhara Bagchi, in 'Representing Nationalism: Ideology of Motherhood in Colonial Bengal' (EPW, October 20-27, 1990, pp.65-71)³⁰ tries to justify the concept from the viewpoints of the patriarchal society. She highlights the thoughts and writings of the stalwarts of Bengal Renaissance and seeks to explore different avenues related to this discourse. In her own words, "The ideology of motherhood in Bengal is a complex phenomenon that needs a full length study. It will involve studies of anthropology, history, politics, literature, mythology and semiotics."³¹

From the twentieth century onwards, concern for maternal health became vital, as it was believed by the physicians and health administrators that, only a healthy woman could give birth to a healthy child. Aparajita Dhar, in 'Western Approach to Infantile Mortality and Delivery Deaths' (History of Medicine in India: The Medical Encounter, Gyan Books, 2005, pp.255-264)³² traces both the colonial and native mentalities regarding this issue.

She mentions the writings of native medical practitioners like Bhibuti Bhusan Bhattacharya who wrote in favor of maternal well-being following the western line of treatment.³³ The Directors of Public Health also shared the same view. Amongst them, Dr. Baman Das Mukerjee was notable.³⁴ Perhaps the genesis of all these can be traced in the writings of Ambuja Sundori, Prabhabati, Laxmimoni, Charumati, Rokeya and others.

If we try to theorize this particular problem, then it is evident that, by criticizing the male members of the society, Prabhabati and Laxmimoni perhaps got a satisfaction. At that time, the number of the educated females was few and most of them through their writings tried to set in a specific culture. They used to highlight the administrative loop-holes, and wanted to change the existing social scenario. Perhaps it was an attempt to challenge the established European, particularly the British concept that, the Indian ladies were only to be born to serve their husband.

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