Abstract—Population in rural areas are scattered in the form of different villages or settlements. The proper selection of land to launch any educational or health activities to equally facilitate both the genders is the sticky situation, both for Govt. and Private organizations. Govt. spends substantial funds for the establishment of education institution/health centre at the place which is feasible and accessible to general public. However for specific gender, the gender population is also considered so that both the gender may be benefited equally. In this research, efforts have been made to illustrate how one can choose or locate the best central place/area in Taluka Kunri of district Umerkot Sindh Pakistan where the Educational or Health activity is to be initiated. For the purpose the concept of centre of mass theorem is used as a tool to develop mathematical model, subsequently utilize in achieving the objectives.

Keywords—Centre of mass theorem, Establishment of technical/vocational/health care centre, Gender population of taluka Kunri of District Umerkot, Graphical interpretation of town committee/villages.

I. INTRODUCTION

Population of rural areas are almost scattered in the form of different tribes or settlement. People fetch their earning through different profession like cultivation of lands, from forest, fishing and livestock. Illiteracy is the basic problem of rural areas. A literate person can take better program to increase literacy rate with the help of community. Moreover, in this regards substantial fund were allocated for the establishment of educational institution.

II. METHODOLOGY AND MODELING

According to centre of mass of a set of a particle of masses \( M_1, M_2, M_3 \ldots M_n \) situated at the points \( P_1, P_2, P_3 \ldots P_n \) whose position vector to an origin \( O \) are \( r_1, r_2, r_3 \ldots r_n \). Then the linear moment of the set of particles with respect to \( O \) is the vector \( \sum_{i=1}^{n} M_i r_i \).

A. Definition

The centre of mass (c.m) of a set of particles is the point with respect to which the linear moment of the set of particles is zero.

B. Theorem [1]-[8]

“Every set of particles has one and only one centre of mass.”

Let the particles \( M_1, M_2, M_3 \ldots M_n \) be located at the point \( P_1(r_1), P_2(r_2), P_3(r_3) \ldots P_n(r_n) \). Suppose \( C (\vec{r}) \) is a centre of mass

The position vector of \( P_i(r_i) \) relative to \( C \) is \( r_i - \vec{r} \)

\[
0 = \sum_{i=1}^{n} M_i (r_i - \vec{r}) \quad \text{where } i = 1, 2, 3 \ldots \ldots n \\
= \sum M_i r_i - \Sigma M_i \vec{r}
\]
Thus centre of mass \( C \) exist and its position vector is \( \sum \frac{M_i r_i}{M} \) Suppose \( C' (r') \) is another centre of mass of the set of particles. Then, reasoning as above, the linear moment of the given set of particles with respect to \( C' \) is zero if and only if \( r' = \sum \frac{M_i r_i}{M} \).

Therefore, \( r' = r \) i.e. \( C' = C \) This proves the uniqueness of the centre of mass.

### C. Cartesian Coordinates of the Centre of Mass

Let \( r_i = (x_i, y_i, z_i) \) and \( r = (\bar{x}, \bar{y}, \bar{z}) \) Then

\[
\bar{x} = \frac{\sum M_i x_i}{\sum M_i}; \quad \bar{y} = \frac{\sum M_i y_i}{\sum M_i}; \quad \bar{z} = \frac{\sum M_i z_i}{\sum M_i}
\]

In case of a coplanar set of particles, the last coordinate of the centre of mass may be ignored by choosing \( x, y \) axis in the plane of the set and in case of a collinear set only one coordinate will be sufficient.

### D. Application of Methodology on Real Data

As a test case, here we have taken seventeen Town committees in Taluka Kunri [10] of district Umerkot in Sindh province of Pakistan, separated each other by different distances having different population and we need to establish Educational Institution keeping in view the area age group distances having different population and we need to establish committees in Taluka Kunri [10] of district Umerkot in Sindh.

**Solution should not be gender bias.**

To facilitate maximum number of children or people.

- Solution should not be gender bias.
- Gender specific centre place of the area would be determined.

Keeping in view the above objectives, best centre or location would be decided. According to the methodology we can use the concept of centre of mass theorem, as the mass of the particles may represent as the population of the area or village/town committees and the position vectors of the town committees’ may be taken from the given fixed points ‘O’ as origin, so each Town committee of Taluka Kunri may be represented by the points of Cartesian Coordinates in xy-plan, so that each town committee can be shown in the form of directed vectors of the town committees’ from the origin ‘O’.

By using concept of centre of mass theorem [1]-[8] the centre point of all town committees of Taluka Kunri of District Umerkot can be calculated. The graph with Tables I and II shows the Town Committees exist in taluka Kunri along with mass population density of the town Committees [9] and the Cartesian coordinate of corresponding town committees’.

Centre of mass point is \((\bar{x}, \bar{y})\)

\[
\bar{x} = \frac{\sum M_i x_i}{\sum M_i}; \quad \bar{y} = \frac{\sum M_i y_i}{\sum M_i}
\]

By applying above formula of centre of mass on the data embodied in Tables I and II we get the following results.

The population of all town committees in Taluka Kunri along with mass population density of the town Committees and the Cartesian coordinate of corresponding town committees’.
(5.54, 8.45) for male and female respectively, which is almost same, and from graph the Cartesian point for desired location is somewhere in southern of Bustan listed at Sr. No 8 in Table I. However, Table II which indicates the population of Taluka Kunri having educational qualification at least Primary but below Metric [9], so to make them useful and skilled citizen, the arrangement of technical / vocational institute is considered mandatory. As such the suitable place for the establishment of institution for both the genders of all 17 town committee are at point (5.63,8.32) and (5.73,8.12) for Boys and Girls respectively, and from graph the Cartesian coordinate for desired location is somewhere in Rindki and Barani listed at sr. No. 5 and 7 respectively in Table II.

### Table II

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Town Committee (TC) of Taluka Kunri District</th>
<th>Population having Elementary Education (Census 1998)</th>
<th>Cartesian Coordinates</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (T&lt;sub&gt;e&lt;/sub&gt;) Male (M&lt;sub&gt;e&lt;/sub&gt;) Female (F&lt;sub&gt;e&lt;/sub&gt;)</td>
<td>(x&lt;sub&gt;e&lt;/sub&gt;, y&lt;sub&gt;e&lt;/sub&gt;)</td>
<td>M&lt;sub&gt;x&lt;/sub&gt;</td>
<td>M&lt;sub&gt;y&lt;/sub&gt;</td>
<td>F&lt;sub&gt;x&lt;/sub&gt;</td>
</tr>
<tr>
<td>1</td>
<td>Char</td>
<td>499 435 64</td>
<td>(3,9,6)</td>
<td>1305 4176 192</td>
<td>614,4</td>
</tr>
<tr>
<td>2</td>
<td>Darelo</td>
<td>401 351 50</td>
<td>(2,8,7,8)</td>
<td>982 2737,8 140</td>
<td>390</td>
</tr>
<tr>
<td>3</td>
<td>Kandiari</td>
<td>400 335 65</td>
<td>(3,8,6,2)</td>
<td>1273 2077 247</td>
<td>403</td>
</tr>
<tr>
<td>4</td>
<td>Manjharak</td>
<td>292 221 71</td>
<td>(4,4,10)</td>
<td>972,4 2210 312,4</td>
<td>710</td>
</tr>
<tr>
<td>5</td>
<td>Rindki</td>
<td>142 179 10</td>
<td>(4,6,7,4)</td>
<td>777,4 1250,6 46</td>
<td>74</td>
</tr>
<tr>
<td>6</td>
<td>Saikdi</td>
<td>545 402 143</td>
<td>(7,8)</td>
<td>2814 3216 1001</td>
<td>1144</td>
</tr>
<tr>
<td>7</td>
<td>Barani</td>
<td>733 569 204</td>
<td>(5,4,10,4)</td>
<td>3072,6 5917,6 1101,6</td>
<td>2121,6</td>
</tr>
<tr>
<td>8</td>
<td>Bustan</td>
<td>1120 833 287</td>
<td>(6,12)</td>
<td>4998 9996 1722</td>
<td>3444</td>
</tr>
<tr>
<td>9</td>
<td>Talhi</td>
<td>998 741 257</td>
<td>(6,6,10)</td>
<td>4890,6 7410 1696,2</td>
<td>2570</td>
</tr>
<tr>
<td>10</td>
<td>Kunri</td>
<td>758 578 180</td>
<td>(8,4,10,6)</td>
<td>4855,2 6126,8 1512</td>
<td>1908</td>
</tr>
<tr>
<td>11</td>
<td>Morjhango</td>
<td>286 214 72</td>
<td>(7,6)</td>
<td>1498 1264 504</td>
<td>432</td>
</tr>
<tr>
<td>12</td>
<td>Dhambharlo</td>
<td>409 295 114</td>
<td>(5,3)</td>
<td>1475 885 570</td>
<td>342</td>
</tr>
<tr>
<td>13</td>
<td>Haido</td>
<td>442 322 120</td>
<td>(5,4,5,4)</td>
<td>1738,8 1738,8 648</td>
<td>648</td>
</tr>
<tr>
<td>14</td>
<td>Mundhawa</td>
<td>325 290 35</td>
<td>(8,7,4)</td>
<td>2320 2146 280</td>
<td>259</td>
</tr>
<tr>
<td>15</td>
<td>Nabisar</td>
<td>533 429 104</td>
<td>(6,7)</td>
<td>2574 3003 624</td>
<td>728</td>
</tr>
<tr>
<td>16</td>
<td>Rahmore</td>
<td>1018 667 351</td>
<td>(4,6,4,2)</td>
<td>3068,2 2801,4 1614,6</td>
<td>1474,2</td>
</tr>
<tr>
<td>17</td>
<td>TOTAL</td>
<td>9120 6967 2153</td>
<td></td>
<td>39395 7590,4 12340,8</td>
<td>17480,6</td>
</tr>
</tbody>
</table>

### Centre of Mass (point)

\[ x_{m,e} = \frac{\sum M_e x_e \Sigma F_e}{\sum M_e \Sigma F_e} \quad y_{m,e} = \frac{\sum M_e y_e \Sigma F_e}{\sum M_e \Sigma F_e} \]

### III. RESULTS AND DISCUSSION

The concept of Centre of mass theorem [1]-[8] is used as a tool to select an appropriate central place for the population density of both the gender of any age group. The site so selected is considered to be best location for the construction of educational institution to facilitate the population gender equally. The feasible place or centre place found is southern of Bustan listed at sr. No. 8 with coordinate (5.5, 8.5) for both gender mentioned in Table I. so, this place is suitable for the establishment of any general purpose Educational Institution or Hospital. However, for the arrangement when considering the construction of specific purpose Educational Institution of Technical/Vocational Institution for both genders’ population mentioned in Table II. The central places will be Rindki with coordinate (5.6, 8.3) for Boys and Barani with coordinate (5.7, 8.1) for Girls listed at sr. No. 5 and 7 respectively in Table II.

### IV. CONCLUSION

Seeking of right central place for initiating social activities is the major dilemma for the population of a particular area. It has been observed that the tendency of gradual increase in population seems in the areas where the peoples feel comfortable to fetch their basic needs. As such in this study, Taluka Kunri [10] of district Umerkot of Sindh province in Pakistan was taken as a test case and by using the concept of centre of mass theorem [1]-[8], a right feasible place for the establishment of Educational Institution / Health Care Centre is obtained, having Cartesian Coordinate (5.5, 8.5) of the mass population of 17 town committees which is located somewhere in the town committee Bustan circled ‘1’ in the graph. However, the right central places for the establishment of Technical and Vocational Institutes for specific gender populations are at Rindki and Barani circled ‘2’ & ‘3 having Cartesian Coordinates (5.6,8.3) and (5.7,8.1) respectively.
Fig. 1 Graph Indicating the Feasible Central Place to Establish the Educational/Technical/Vocational Institute and Health Care Centre to Facilitate the Local Population of Taluka Kunri
REFERENCES