CHAPTER 9.0
MEDIUM ENTERPRISE
CONTINUOUS PROCESS - SINGLE PRODUCT

9.1 ABSTRACT

Sugar is a key variable in national well being. It is a constituent of the nation's wage goods. It assuages the hardships of development and as an energy producing substance contributes to the nutritional norm for children, pregnant mothers, work force and the less privileged section of the population. This, of course, implies a certain linearity of production function with a view to maximize output. Despite high starting prices for cane, high and differential fiscal levels and policies, increased levy quotas alongside of inflexible controlled prices and favoured treatment of Khandasari and Gur as substitutes, the sugar industry and its investment in it have been growing because of unsatisfied potential demand. In this industrial scenario the sugar industry cannot forgo any small percentage of loss in any part of production line. The industry under study was with a production loss and a study was conducted on this aspect and reported to be the leakage of cane extract in 125 pumps in the production line. A mechanical seal was designed to arrest the same and a cost analysis was made to find the performance improvement for various types of seals over the conventional rope & gland technique. A mathematical model is arrived for the curve plotted for percentage improvement in performance against total cost of rope technique to decide the rigorousness of the industry towards re-engineering.

9.2 ABOUT THE INDUSTRY

The enterprise is a sugar producing industry, established in 1989, employs about 1000 workers. It produces 3,000 bags of sugar per day at present and also produces spirit from the molasses of the sugar cane as a byproduct. It has its own machine shop for plant maintenance and also a laboratory for its research purposes.

It is important to decide on the benefit expected from the sugar industry for commonweal and for the overall economical development. The industry's attitude towards the commodity has been one of obsession with growth regardless of other
considerations (output being inelastic) which brings to the fore the important distinctions being entrepreneurship, administration and production. Despite high starting prices for cane, high and differential fiscal levels and policies, increased levy quotas alongside of inflexible controlled prices and favoured treatment of Khandasari and Gur as substitutes, the sugar industry and its investment in it have been growing because of unsatisfied potential demand. A commodity like sugar should be supplied at a steady price and only having surplus capacity of storage and acquisition of stocks can do this. Under this circumstances the industry cannot forgo any smallest percentage of wastage in its production line.

9.3 PROCESS DIAGNOSIS

The industry is with a production loss of sugar from its total sugar cane crushing and thereby increases in production cost. A study was conducted on this aspect and the following internal technical factors were reported.

- There is a loss in the total production of sugar because of leakage of liquid (Sugarcane Extract) in various pumps.
- In the existing setup there is a need of exchanging the rope in the packing gland of all pumps every month. Hence maintenance cost is high.
- The leakage of liquid becomes a mess and contaminates the environment creating an unhealthy working condition and spoils the total atmosphere.
- Cleaning of the liquid leaking spillage from the pumps requires additional labour cost.

Study details of the liquid loss due to leakage of the pumps:

<table>
<thead>
<tr>
<th>Total crushing of sugarcane / day</th>
<th>3000 Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sugar produced per day</td>
<td>3000 Bags</td>
</tr>
<tr>
<td>Loss of liquid due to pump leakage</td>
<td>4.5 tons</td>
</tr>
<tr>
<td>Extrapolated from lab experiments</td>
<td>0.15% of the total crushing</td>
</tr>
</tbody>
</table>

Loss of liquid occurs at many stages of the continuous sugar making process. In the present setup, the pump gland consists of the rope and stuffing box arrangement. The
rope in the stuffing boxes losses its properties and needs to be changed once a month for
the 125 pumps that are in the process line. Whenever there is any breakdown in the
machinery or during the process of maintenance, the field officers may have to be
contacted without any loss of time for instructions to stop cutting of cane else they would
get dried up before crushing. This would lead to reduction sucrose in the case thereby a
loss in the sugar extraction upon completion of the process. This loss is an opportunity
cost, which is not included in cost calculation.

Table 9.1 Gland Rope details for the Pumps

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Pump rating</th>
<th>No. pumps</th>
<th>Rope Size</th>
<th>Cost per Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.0 hp</td>
<td>25</td>
<td>¼” x 2 m</td>
<td>Rs. 150</td>
</tr>
<tr>
<td>2</td>
<td>7.5 hp</td>
<td>50</td>
<td>½” x 2 ½ m</td>
<td>Rs. 190</td>
</tr>
<tr>
<td>3</td>
<td>10.0 hp</td>
<td>30</td>
<td>5/8” x 3 m</td>
<td>Rs. 255</td>
</tr>
<tr>
<td>4</td>
<td>12.0 hp</td>
<td>20</td>
<td>1” x 3 m</td>
<td>Rs. 300</td>
</tr>
</tbody>
</table>

The cost analysis is as given below.

Labour cost to change ropes & cleaning

Time taken to change gland rope for 1 pump = 1 hour app.
No. of persons needed for changing rope for per pump = 2
Labour cost per hour @ Rs.150 per day = Rs.18.75
Labour cost to change rope per pump = Rs.18.75 x 2
= Rs. 37.50
Labour cost to change ropes per pump per year = 37.50 x 12
= Rs.450
No. of labour needed / shift for cleaning the leakage = 5
Labour cost per shift = Rs.60
Total labour cost for cleaning = 60 x 5 x 300
= Rs. 90, 000
Labour cost for cleaning per pump / year = 90,000 / 125
= Rs.720
Total labour cost of changing & cleaning per pump per year = Rs. 450 + Rs. 720
= Rs.1170

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Table 9.2 Cost Details Before Re-engg.

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Pump Rating (hp)</th>
<th>Cost of Rope per Pump (Rs)</th>
<th>Labour cost for replacement (Rs)</th>
<th>Cost of rope along with labour cost / pump / year (Rs.)</th>
<th>Total Cost / pump / year (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>1,800</td>
<td>1,170</td>
<td>2,970</td>
<td>2,970</td>
</tr>
<tr>
<td>2</td>
<td>7.5</td>
<td>2,280</td>
<td>1,170</td>
<td>3,450</td>
<td>3,450</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>3,060</td>
<td>1,170</td>
<td>4,230</td>
<td>4,230</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>3,600</td>
<td>1,170</td>
<td>4,770</td>
<td>4,770</td>
</tr>
</tbody>
</table>

Cost of material wastage (sugarcane extract)

Daily production of sugar = 3000 bags
Total production / year = 3000 x 300 = 9,00,000 bags
Total loss due to leakage in pump (0.15% of production) = 1350 bags
Total loss in value @ Rs. 1,000 per bag = Rs. 13,50,000

9.4 PROCESS REDESIGN

Process diagnosis revealed the heavy loss to the company due to pump leakage. The rope life was very poor and had to be continuously changed. The primitive method of rope and stuffing box was not effective in arresting the leakage that warranted a necessity to innovate an alternative. The team in the lab has designed a mechanical seal, which totally arrested the leakage. The photographs of which are shown in Fig 9-1 & Fig 9.2. The leakage was totally arrested by using this mechanical seal. Further the mechanical seal has a longer life and it has to be changed once in a year only.

Fig 9.1 Exploded View of the Seal
Fig 9.2 Assembled View of the Seal
The cost details of the mechanical seals are as given below.

No. of persons needed to change the seal = 2
Time taken to change mech. seal for 1 pump = 1 hour app.
Labour cost per hour @ Rs.150 per day = Rs.18.75
Labour cost to change seal per pump per year = Rs.18.75 x 2 = Rs. 37.50 / Pump

Table 9.3 Cost Details of Mech. Seals

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Pump Rating (hp)</th>
<th>Cost of Seal (Rs)</th>
<th>Labour cost for replacement (Rs)</th>
<th>Cost of Mechanical seal &amp; Fixing cost per pump/year (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>600</td>
<td>37.50</td>
<td>637.50</td>
</tr>
<tr>
<td>2</td>
<td>7.5</td>
<td>700</td>
<td>37.50</td>
<td>737.50</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>850</td>
<td>37.50</td>
<td>887.50</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>1,000</td>
<td>37.50</td>
<td>1037.50</td>
</tr>
</tbody>
</table>

9.5 PERFORMANCE ANALYSIS

The production loss of Rs.13.5 lakhs is recovered by expending Rs.95, 000 as yearly replacement cost on mechanical seals for 125 pumps resulting in a total saving of Rs. 12.55 lakhs per year. Further the savings and the percentage improvement in savings before and after BPR were calculated and tabulated (Table 9.4).

Table 9.4 Performance Improvement in Cost

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Pump rating (HP)</th>
<th>Cost of rope &amp; labour cost/pump/year (Rs.)</th>
<th>Cost of Mechanical seal &amp; Fixing cost per pump/year (Rs.)</th>
<th>Savings due to Re-engineering (Rs.)</th>
<th>Percentage Improvement In cost %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.0</td>
<td>2970</td>
<td>637.50</td>
<td>2332.50</td>
<td>78.5</td>
</tr>
<tr>
<td>2</td>
<td>7.5</td>
<td>3450</td>
<td>737.50</td>
<td>2712.50</td>
<td>78.6</td>
</tr>
<tr>
<td>3</td>
<td>10.0</td>
<td>4230</td>
<td>887.50</td>
<td>3342.50</td>
<td>79.0</td>
</tr>
<tr>
<td>4</td>
<td>12.0</td>
<td>4770</td>
<td>1037.50</td>
<td>3732.50</td>
<td>78.2</td>
</tr>
</tbody>
</table>

A graph was plotted for the Percentage Improvement in Cost vs. Total cost of rope per pump per year (Graph 9-1), and a mathematical model was arrived for the curve.
Mathematical Model

The mathematical model for this curve is

\[ Y = a \]

where

- \( Y \) is the % improvement in cost saving
- \( a \) is a constant.

Graph 9-1

As the loss due to leakage was almost totally arrested the value of the yearly waste of cane extract is apportioned to each pump.

- Total loss of sugar in value per year before BPR = Rs. 13,50,000
- Loss due to leakage per pump per year before BPR = Rs. 13,50,000 / 125 = Rs. 10,800

The percentage improvement in total savings was calculated and tabulated (Table 9.5).

<table>
<thead>
<tr>
<th>SL No</th>
<th>Pump Rating (hp)</th>
<th>Cost of Rope &amp; Labour Cost / Pump / Year (Rs.)</th>
<th>Leakage Loss / Pump / Year (Rs.)</th>
<th>Total Loss / Pump / Year (Rs.)</th>
<th>Cost of Seal &amp; Fixing Cost / Pump / Year (Rs.)</th>
<th>Total Savings / Pump / Year (Rs.)</th>
<th>Percentage Improvement in Total Savings %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.0</td>
<td>2970</td>
<td>10,800</td>
<td>13,770</td>
<td>637.50</td>
<td>13,132.50</td>
<td>88.5</td>
</tr>
<tr>
<td>2</td>
<td>7.5</td>
<td>3450</td>
<td>10,800</td>
<td>14,250</td>
<td>737.50</td>
<td>13,512.50</td>
<td>94.8</td>
</tr>
<tr>
<td>3</td>
<td>10.0</td>
<td>4230</td>
<td>10,800</td>
<td>15,030</td>
<td>887.50</td>
<td>14,142.50</td>
<td>94.1</td>
</tr>
<tr>
<td>4</td>
<td>12.0</td>
<td>4770</td>
<td>10,800</td>
<td>15,570</td>
<td>1037.50</td>
<td>14,532.50</td>
<td>93.3</td>
</tr>
</tbody>
</table>

A graph was plotted for the Percentage Improvement in total savings vs. Total loss of rope / pump / year before BPR (Graph 9-2), and a mathematical model was arrived.
MATHEMATICAL MODEL

The mathematical model for this curve is

$$Y = aX^2 + bX + c$$

where

- $Y$ is the % improvement in Savings
- $X$ is the Total loss /pump/year before BPR
- $a$, $b$, and $c$ are constants.

Graph 9-2

9.6 CONCLUSION

Graph 9-1 shows fixed percentage of improvement, an ideal curve, as expected after re-engineering. Though Graph 9-2 shows quadratic behaviour, it is due to less number of 5 & 12 hp pumps. This might also reflect the same behaviour if the loss due to leakage was apportioned to pumps based on the performance. After re-engineering, each pump indirectly earns approximately Rs. 10,000 per year for its stakeholders as income over expenditure after its yearly maintenance cost, which is a significant development. But the rigorousness of its approach towards BPR is questionable.

The problem was set to the limit as arresting the leakage of cane-extract from pumps at various stages of the production process. Had it been defined as increase in production, the team would have worked methodically and would have listed out more core problem areas for development in which leakage of pumps would also find a place. The industry faces the following problems either fiscal or industrious in nature.

- To keep stock of sugar to meet the fluctuations in the market.
- To match the production requirement with the sugarcane cutting.
- To cultivate quality canes in the industry owned fields.
To promote quality product.
To promote agricultural research to improve cane quality & productivity of the growers.
To meet the premium prices of the cane having more sucrose content.
To apportion the machinery cost that will have to be secured for modernization and expansion.
To match the requirement and cost of sulphur and other imported items required for the manufacture.
To match the Government fixed statutory cane and sugar price.
To fully explore the by-products namely molasses and bagasse that will put the industry on an economical footing.
To economically convert molasses into Alcohol before it starts deteriorating.
To explore the manufacture of fermented chemicals and make available naphtha for the manufacture of fertilizers, pesticides and other petro-chemicals.
To promote the utilisation of bagasse in paper and paper boards production.
To understand the proper relationship among Khandasari, Gur and Sugar prices.
To stop cane cutting without any loss of time if there is any breakdown else cane would get dried up.
To develop new techniques in marketing
To evaluate the cost-profit analysis of installing separate boilers to use bagasse and furnace oil as alternative fuels since bagasse is also required for paper mills.
To meet the rising demand of the commodity and to compete with the similar industry.
To promote export of sugar.
To develop human resources for a change.

All the above factors calls for the determination of the size of the factory, farm size, farm development, rotation of crops, development in the cane extraction process, crushing capacity, economic size, develop a number of ancillary industries like alcohol, paper form bagasse, new marketing strategies and exporting. Government policies play a vital role in every aspect of the above development that they should be developed within those constraints.
A real application of BPR could be possible in this industry that an economical production line balancing, product mix, diversification, investment policy, strategic planning, human resource development etc shall be arrived, resulting in a total radical change. Hence it is essential that entire process should have been re-engineered from process mapping instead of finding solution to a specific problem which is not a complete re-engineering process. Hence it is concluded that this industry (Medium Enterprise – Continuous Process – Single Product) is less rigorous in its approach towards BPR. The discussion is consolidated in chapter 11.4.4.