The economics of wastewater treatment in water intensive manufacturing processes

e.g. example of textile manufacturing in Ethiopia

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By 2023, denim production will exceed 9.1 billion meters.

By 2025, global denim production will reach 25.4 billion dollars.

Textile industry generates nearly 20% of the global wastewater.

In undeveloped countries, wastewater is always discharged into the environment due to the lack of a supervisory system.
Background

- **Superior natural conditions**
  - Vast land area
  - Climate conditions that are suitable for cotton production
  - Abundant and cheap water and electricity resources

- **Abundant labor resources**
  - 54 million labor force
  - A large number of educated people

- **Policy Support**
  - A set of preferential policies
  - A number of trade preferential agreements
  - Export tariff preferences to Europe and the United States
Some important assumptions

• Assumptions in Manufacturing process
  - The production is made of 100% cotton.
  - Only focus the main production process of jeans.
  - The whole production process takes place in Ethiopia.
  - The jeans plant produces 50000 pairs of jeans every day

• Assumptions in wastewater treatment process
  - The quality of wastewater is known and unchanged.
  - Sludge treatment will not be taken into consideration.
  - Wastewater treatment plant treats wastewater from 60 same jeans production.

• Other Assumptions
  - No transportation cost will be taken into consideration.
  - Only one party would be responsible for the fee occurred during the business line.
Methods

1. Literature Review
   - Identify the research boundaries
   - Life cycle analysis for Denim production

2. Identify raw materials and other input substances
3. Costing structure
4. Identify the pollutants
5. Determine sewage standards
6. Choose sewage treatment process
7. Calculate the cost of wastewater treatment

Conclusion
Result: Costing structure

Cost structure of a pair of jeans/

Total cost of manufacturing a pair of jeans: 2.27607$
How much will the jeans price increase if the manufacturers pay for the wastewater treatment?
Wastewater Treatment

Regulation, Method and Economic Calculation
Regulation and consideration

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<thead>
<tr>
<th>Parameters</th>
<th>Guideline limit</th>
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<tbody>
<tr>
<td>pH</td>
<td>6.00-9.00</td>
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<tr>
<td>TSS</td>
<td>≤60 mg/l</td>
</tr>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>≤30 mg/l</td>
</tr>
<tr>
<td>COD</td>
<td>≤100 mg/l</td>
</tr>
<tr>
<td>Color</td>
<td>≤70</td>
</tr>
<tr>
<td>Temperature</td>
<td>≤37°C</td>
</tr>
</tbody>
</table>

- Our own regulation. (Levi Strauss & Co, GB 4287-2012)
- The higher-value one (easier-to-achieve one) among these two rules is chosen
What are we dealing with

- Denim production
  - Only blue jeans made of cotton and dyed by indigo (2,2’-Bis(2,3-dihydro-3-oxoindolyliden))
- 30000 pair of jeans produced per day
- Amount of water
  - 3000 tons per day

<table>
<thead>
<tr>
<th></th>
<th>COD</th>
<th>BOD₅</th>
<th>TSS</th>
<th>Color</th>
<th>Temperature</th>
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<td>Influent</td>
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<td>1700 mg/l</td>
<td>200 mg/l</td>
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<td>30 mg/l</td>
<td>60 mg/l</td>
<td>70</td>
<td>37°C</td>
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</table>

* : not known yet, but will be calculated with the concentration of dye instead
**: varies from seasons
Wastewater treatment method
Economic calculation

- **Energy**
  - Pumps: pump station, sedimentation tank, CAST tank, disinfection tank

- **Consumables**
  - Slaked lime and ferric chloride (Coagulant), activated carbon, sodium hypochlorite

- **Salary**
  - 20 workers with relatively high salary in Ethiopia (6 USD per day)
Price Increase, Possible Improvement and Our Assumption
Price increase

- 30000 pair of jeans, **1434.49 USD** (one day)
- Each pair of jeans increase (without construction and facility cost)
  - **0.04782 USD**, 2.1008% of total cost
- Each pair of jeans increase (with construction and facility cost)
  - **0.1960 USD**, 8.600% of total cost

Reduce the wwt price

- Better dyeing method: estimated 3% is wasted, could be lower. Less activated carbon will be used;
- Better absorption method: activated carbon is used, but this is so expensive.
- Better consumables suppliers. Now from India, but local supplier is preferred.