Assessing Leanness of Fast-Moving Consumer Goods (FMCG) Industry with Fuzzy Logic

Narender Kumar, S. K. Jarial, M. S Narwal

Abstract: The purpose of the study is to calculate the leanness of FMCG (fast moving consumer goods) industry. For this a questionnaire was prepared on the basis of enablers and criteria. Interviews were conducted with the Manager (Admin), Production Manager, Quality Officer, Sale and Purchase officer, Lab Chemist, Engineers based on the questionnaire. The case industry is availing benefits of Lean concept since three year and six months. However, there is room for further improvement.

Keywords: Measurement of leanness, lean concept, Fuzzy Logic, FMCG Industry.

I. INTRODUCTION

Every industry wants to reduce the wastes. Lean concept is concentrated on the reduction of industrial wastes. Lean concept help to minimize seven wastes. There are lots of industries using lean concept in various sectors like manufacturing, automobile, pharmaceuticals, textile etc. There was the need of leanness assessment because benefits of assessment are to identify the current state, track the overall performance of production plant and to find weak areas. A number of researchers have used certain methodologies to measure leanness of manufacturing sector. Most of the researchers use fuzzy logic approach to calculate leanness index. There is need of leanness assessment in FMCG industries.

II. LITERATURE REVIEW


Ali Azadeh, Mansour Zarrin and et al. [21] presented a method to measure and optimize the leanness level of packing and printing organizations by using DEA, FDEA, FCM, DEMATEL and AHP techniques. Anita Susilawati, John Tan and et al. [22] proposed an approach to deal with the multidimensional theory, absence of benchmarking and vagueness for the measurement of leanness of manufacturing industry. Chhabi Ram Matawale, Saurav Datta and et al. [23] delivered an effective system to calculate the level of leanness of the automobile part manufacturing industry supply chain with the help of generalized trapezoidal fuzzy numbers.


III. RESEARCH METHODOLOGY

The research work flow throughout this work is shown in fig. 1. According to previous research articles there is less work on leanness calculation in this type of industry. After it enable, criteria were selected. These enable and criteria have been chosen from the research of S. Vinodh and K. E. K. Vimal [13] according to suitability of FMCG industry and data collection. And some criteria were merged. The enable and criteria are shown in fig. 2. Questionnaire was developed on the basis of five enablers, thirteen criteria and fifty three attributes on five like-likert scale. The whole organization is considered as a system and divided into five parts. The questionnaire covers several views of leanness assessment. The experts are the different designation persons in the industry. Experts assigned importance weightage of enable, criteria and attributes and assigned the performance rating to all attributes. To approximate linguistic terms Triangular fuzzy numbers is used. Three assessments have been done with the help of fuzzy (submission, subtraction, multiplication and division) operations for calculation of ILI (Industrial leanness Index). Industrial leanness Index has been compared with the natural expression linguistic levels to calculate the level of leanness of the case industry using Euclidean distance approach. To find weak areas or hurdles PPIS (Fuzzy performance importance score) has been calculated to improve these areas.

IV. CASE STUDY

A. Brief of case industry

The present work has been conducted in a well-known bakery product making organization located in sonapat, Haryana, India. The organization is medium scale enterprises. This organization makes Rusk, suzi rusk, Toast, noodles. The organization exports their products to foreign countries also. The organization has been certified with ISO, (food safety and standards authority of India), US FDA (United State Food and Drug Administration), HALAL (accredited by JAKIM Malaysia), and BRC. The organization has been used Lean concept strategies like TPM, 5S, Kaizen, TQM, TEI (Total employee involvement, Statistical process control and Six Sigma since three year and six months.

[Diagram of Research Methodology]

Literature Review on Leaness assessment and Fuzzy Logic

Gap Identification

Enable and Criteria are selected from literature for lean

Preparation of Questionnaire on the basis of enable and criteria

Identification of organization which are using high lean technique for case study

Responses Received from different level persons of that particular organization

Conversion of Qualitative terms into quantitative terms

Calculation of Fuzzy leanness Index

Match Leanness level

Rank fuzzy performance importance index (FPIS)

Weak Areas to improvement

Suggestions to improve weak areas

Fig. 1 Research Methodology
The lean index for “Streamlining of processes” criteria is shown as follows

\[ LI_{22} = \text{Lean index of } 2^{nd} \text{ criterion on } 2^{nd} \text{ enabler} \]

\[ LI_{22} = \begin{pmatrix} 0.25, 0.50, 0.75 & \otimes & (5, 7, 5, 10) & \oplus \\ 0.50, 0.75, 1 & \otimes & (5, 7, 5, 10) & \oplus \\ 0.50, 0.75, 1 & \otimes & (5, 7, 5, 10) & \oplus \end{pmatrix} \]

\[ LI_{22} = [5, 7, 5.10] \]

Leanness index of all criterions is calculated as shown in table IV.

**D. Calculation of Enabler’s leanness**

Calculation of lean index for “Management Responsibilities” enabler are shown as follows

\[ LI_i = \begin{pmatrix} 0.50, 0.75, 1 & \otimes & (5, 7, 37, 9.64) & \oplus \\ 0.50, 0.75, 1 & \otimes & (5, 7, 5, 10) & \oplus \end{pmatrix} \]

\[ LI_i = [5, 7.4, 9.82] \]

Leanness index of all enablers is calculated as shown in table IV.

**E. Calculation of system’s leanness**

\[ ILI \text{ (Industrial leanness index) of the industry} \]

\[ \begin{pmatrix} 0.50, 0.75, 1 & \otimes & (5, 7, 4.9, 82) & \oplus \\ 0.50, 0.75, 1 & \otimes & (5, 7, 5, 10) & \oplus \\ 0.50, 0.75, 1 & \otimes & (5, 7, 5, 10) & \oplus \end{pmatrix} \]

\[ ILI = \begin{pmatrix} 0.50, 0.75, 1 & \oplus \\ 0.50, 0.75, 1 & \oplus \\ 0.50, 0.75, 1 & \oplus \\ 0.50, 0.75, 1 & \oplus \end{pmatrix} \]

\[ ILI = [5, 7.5, 9.96] \]

There is a need to compare ILI (Industrial leanness index) with standard leanness level. There are some methods to compare the ILI and standard leanness level. Frequently preferred distance method is Euclidean distance method. The plus point of this method is the distance between any two items remains unchanged when we add new items in the analysis as compare to other methods. In this method, the natural language notation ILI (Equivalent fuzzy number for natural language notation table ID = {poor lean (PL), fair lean (FL), lean (L), high lean (HL), extreme lean (EL)}) is chosen for tagging. The linguistics levels and equivalent numbers are shown in fig. 3. Distance D from the ILI to each standard level is calculated with the help of the Euclidean distance method Eq. 3.

\[ D = \frac{\sum_{i}^{n} (R_{ij} \times W_{ij})}{\sum_{j} W_{ij}} \]

\[ LI_i = \text{Lean index of criteria} \]

\[ W_{ij} = \text{Weight of importance of attribute} \]

\[ R_{ij} = \text{Rate of performance of attribute} \]
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\[ D(ILI, LL_i) = \sqrt{\sum (f_{ILI}(x) - f_{LL_i}(x))^2} \]  \hspace{1cm} (3)

D (ILI, LL_i) = Euclidean distance between I LI and LL_i
ILI = Industrial leanness index
LL_i = Corresponding fuzzy number for natural language notation
\[ f_{ILI}(x) = \text{fuzzy numbers of I LI} \]
\[ f_{LL_i}(x) = \text{fuzzy numbers of LL_i} \]

Similarly

D (ILI, HL) = 1.56
D (ILI, L) = 4.4
D (ILI, FL) = 7.77
D (ILI, PL) = 10.34

![Comparison of ILI with Linguistic levels](Image)

**Table Equivalent fuzzy number for natural language notation**

<table>
<thead>
<tr>
<th>PL</th>
<th>0</th>
<th>1.5</th>
<th>3</th>
<th>4.5</th>
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</thead>
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<tr>
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<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>3.5</td>
<td>5</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>HL</td>
<td>5.5</td>
<td>7</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>EL</td>
<td>7</td>
<td>8.5</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

V. RESULT AND DISCUSSION

The case industry is found “high lean” after comparing the linguistic levels with I LI. Red triangle shows the leanness level of case industry which is nearer to the HL as shown in fig. 3. It is also confirmed with mathematical calculation. Leanness level is 1.5 distance away from HL which is minimum. It is also useful to find the weak areas/ hurdles. FPIS is combination of rating of performance and weightage of every attributes. It denotes an effect which will show the level of leanness of FMCG industry. If the value of FPIS of a factor is low it means the contribution of this factor is less. [31] The value of transformation (W_{ijk}) is low because the value of W_{ijk} is high. So, for every attribute ijk, FPIS_{ijk} is defined as
\[ FPIS_{ijk} = W_{ijk} \otimes R_{ijk} \] \hspace{1cm} (4)

\[ FPIS_{ijk} = \text{FPIS for ijk}^{th} \text{ attribute} \]
\[ W_{ijk} = \text{Complement of ijk}^{th} \text{ attribute’s weightage} \]
Where W_{ijk} = [(1,1,1) - W_{ijk}]. W_{ijk} is the weightage of attribute ijk [31]. Then FPISs of every attributes are calculated by using eq. 4. For example, the calculation of FPIS_{116} attribute is shown below
\[ FPIS_{116} = (0.25, 0.5, 0.75) \otimes (2.5, 5.7, 5.5) \]
\[ FPIS_{116} = (0.63, 2.5, 5.63) \]

FPIS of all attributes are calculated using this formula as shown in table V. The ranking index of all attributes has been calculated by using eq. 5. Where a, is lower fuzzy number, b is middle fuzzy number, and c is upper fuzzy number.

\[ \text{Ranking Index} = \frac{a + 4b + c}{6} \] \hspace{1cm} (5)

For example the calculation for the FPIS_{116} attribute is shown below
\[ \text{Ranking Index} = \frac{0.63 + 4 \times 2.5 + 5.63}{6} = 2.71 \]

The ranking index of all attributes is shown in table VI. Scale three was set after the discussion with experts to identify the few critical weak areas. It is found that only four attributes have low performance. Appropriate actions have been suggested to the concern industry to improve the weak areas. There are only four weaker attributes (* mark in table VI) which have need for improvements which are as shown in table V with improvement methods.

VI. CONCLUSION

Lean concept is a combined manufacturing approach which is useful to maximize the capacity and minimize the variability. [32] Leanness is the measurement of performance of lean strategies [1]. Some authors have introduced certain methodologies for calculation of leanness. In this study leanness of FMCG is calculated with the help of fuzzy logic approach. Leanness level of the FMCG industry is found high lean is found by using Euclidean distance method. I LI and FPIS are calculated. FPIS is useful to find the weaker areas. Four attributes are found weak from 53 attributes.

FUTURE SCOPE

The leanness has been calculated in a single FMCG industry. In future we can calculate leanness of many FMCG industries of different products. There are possibilities of comparison of global FMCG industries leanness.
Table-III: Received responses after discussion.

<table>
<thead>
<tr>
<th>Lj_k</th>
<th>Lj_1</th>
<th>Lj_2</th>
<th>W_1</th>
<th>W_2</th>
<th>R_1</th>
<th>Lj_3</th>
<th>Lj_4</th>
<th>W_1</th>
<th>W_2</th>
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</table>

Table-IV: Fuzzy index of all Criteria and all Enablers.

<table>
<thead>
<tr>
<th>Lj_1</th>
<th>R_1</th>
<th>Lj_2</th>
<th>R_2</th>
<th>Lj_3</th>
<th>R_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lj_1</td>
<td>(4.64, 7.05, 9.5)</td>
<td>Lj_2</td>
<td>(5, 7.5, 10)</td>
<td>Lj_3</td>
<td>(4.82, 7.28, 9.75)</td>
</tr>
<tr>
<td>Lj_2</td>
<td>(5, 7.5, 10)</td>
<td>Lj_3</td>
<td>(5, 7.5, 10)</td>
<td>Lj_4</td>
<td>(5, 7.5, 10)</td>
</tr>
<tr>
<td>Lj_3</td>
<td>(4.58, 6.88, 9.32)</td>
<td>Lj_4</td>
<td>(5, 7.5, 10)</td>
<td>Lj_5</td>
<td>(5, 7.5, 10)</td>
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<td>Lj_4</td>
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Table-V: Weak areas with improvement methods.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Weaker attributes</th>
<th>Improvement methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lj_24</td>
<td>Wastes reduced after Lean implementation in industry.</td>
<td>Use of Leanness measurement techniques.</td>
</tr>
<tr>
<td>Lj_25</td>
<td>Effect of Lean tool/techniques on Industrial wastes.</td>
<td>Use of Leanness measurement techniques.</td>
</tr>
<tr>
<td>Lj_23</td>
<td>Employees drive suggestion programs time to time in industry.</td>
<td>Rewarding scheme.</td>
</tr>
<tr>
<td>Lj_26</td>
<td>Authority distributed to employees to correct problems.</td>
<td>Training to correct problems.</td>
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Table VI: Fuzzy performance importance Score and Ranking Index of all lean capability

<table>
<thead>
<tr>
<th>L1ijk</th>
<th>FPIS</th>
<th>Ranking Index</th>
<th>L1ijk</th>
<th>FPIS</th>
<th>Ranking Index</th>
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<tr>
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<tr>
<td>L116</td>
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REFERENCES


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