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A Comparative Analysis of Industrial Leanness Index, Weak Areas, Ranking Score and Performance Importance Score for Indian Food Processing Industries

Narender Kumar[1], M. S. Narwal[2], S. K. Jarial[3]
[1]Deenbandhu Chhotu Ram University of Science and Technology, India
[1]narenbhankhar@gmail.com, [2]narwalmohi@rediffmail.com, [3]s.jarial@rediffmail.com

ABSTRACT

In previous research, authors evaluate leanness in various types of industries like manufacturing, service, aerospace, automobile, electronics, wood, ceramics, packaging and printing. There is small wrk on assessment of leanness for food processing industry as per literature. The fuzzy logic is generally used approach to find the leanness level of any company. Fuzzy approach is used to convert the questionnaire's responses into mathematical values. In this case study based paper; the fuzzy logic is used to check the current status of implemented lean strategies of two food process enterprises one is a bread manufacturing company and other is rusk and noodles making company. Leanness level of both case companies is shown graphically using MATLAB. And a comparison of leanness of both organizations has been done to find common popular used highly beneficial lean practices. The basic motivation behind this work is to find commonly used lean practices in food processing industries and also find the weak areas of food processing industries where improvement is needed.

Key words: Lean Strategies, Leanness Assessment, Food Processing Industry, Fuzzy Logic.

1. INTRODUCTION

In the present time of globalisation every enterprise is trying to sustain in competitive market and wants to increase its global presence and leadership. To attain this, an organisation has to produce quality products at low cost with less delivery time. To tackle these challenges in effective way, organisations have to change their existing way of running business to lean concept. Every system has three kinds of activities first which add value, second which don't add value and third which are necessary but don't add value. Main work of Lean concept basically is to minimising those activities and processes which don't add value. But we can't eliminate all waste or zero waste. Every organisation can only minimise the waste. [50] Lean concept focuses on providing quality products in the shortest time at lowest cost which fulfil the needs of customers. All firms want waste free processes. The lean's meaning is all activities or processes without any kind of waste (Muda in Japanese) held in organisation. At present, a lot of enterprises are trying to implement it. [51] And a lot of have already implemented this concept. A lot of enterprises have implemented selected practices of lean concept as per their need and some have implemented a whole range of lean practices. There are different kinds of organisations that have availing the advantages of lean concept. Many organisations adopted and implemented lean concepts effectively and reported excellent results, but there is failure also due to an improper implementation of lean practices. To prevent such failure, it is essential to check the status of leanness after the implementation of new lean strategy.

2. LITERATURE REVIEW IN INDIAN AND GLOBAL CONTEXT

Literature review has been done systematically. Firstly we have search research papers with the help of keywords Leanness Assessment, Leanness calculation, leanness measurement, effects of and lean manufacturing from different data base like Google scholar and Science direct. After study, we chose papers related to leanness assessment of food Industries (table 1), leanness assessment with fuzzy logic (table 2), and leanness assessment Parameters (table 3). All research papers are from reputed journals of top publishers like Elsevier, Springer, Taylor and Francis Group, and Emerald which is shown in figure 1.

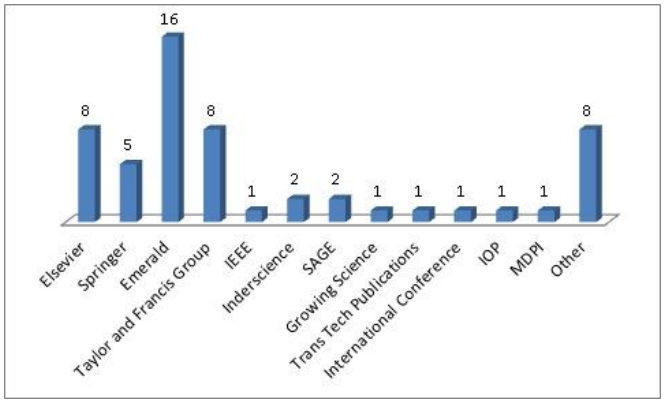

Figure 1: No. of Research papers from Reputed Publishers

Table 1: Literature Review on leanness assessment of food industries

Authors	Area of Applications	Leanness Assessment Techniques	Observations
He X and Hayya J C 2002, USA	Dairy, Baking, Meat and Poultry	Pilot survey	Calculated JIT performance by sending 198 questionnaires. Out of these 60 received and 48 found useful from different industry.[55]
Khusaini N S et al. 2014, Malaysia	Food and Beverages Industry	Pilot survey analysed with SPSS and Rasch Model	Determined most preferable and least preferable lean practices on the basis of 53 questionnaires out of 300 from different companies.[29]
Haq AN and Boddu V 2015, India	Food supply chain	Fuzzy QFD and Topsis	Increased the level of leanness in an industry.[3]
Afonso H and Cabrita MDR 2015, Portugal	Food supply chain	Balanced Score card and AHP	Calculated degree of leanness on the basis of Financial, customer, internal business, learning, and innovation perspective within an industry.[20]
Alaskari O et al. 2016, Libya	Soft drink	Importance and impact index equations	Developed a methodology to find appropriate lean tool for maximum benefit within an industry.[32]
Satolo G E et al. 2016, Brazil	Sugarcane agribusiness	Data triangulation	Evaluated the use of lean practices within an industry.[14]
Bezuidenhout C N 2016, South Africa	Tomatoes, onion and Fruits supply chains	Percentage underutilization with Euclidean distance	Purposed an approach for the assessment of the agility and degrees of leanness within a fruits supply network on the basis of time parameter.[7]
Psomas E, et al. 2018, Greece	Meat, beans, beverages, honey, Pizza	Survey	Determined the current status of the Lean strategies adopted by organisation on the basis of nine industries (Two responses from each).[13]
Maware Cand Adetunji O 2019, Zimbabwean	Pharmaceutical, plastic, Food, and Beverage etc.	Survey	Determined the impact of lean manufacturing on organizational operational performance with 35 percent response rate by SPSS.[10]

Table 2: Previous works on assessment of leanness with fuzzy logic

Authors	Area of applications	Observations
Lin CT et al. 2006, Taiwan	Manufacturing	Developed a framework to measure the agility with the help of fuzzy logic on the basis of ten Parameters like technology, education, Competence, Quality, Integration, Team building, Change, Partnership, market, and welfare.[8]
Bayou M E and Korvin A D. 2008, USA	Automobile	Made a standard system to check the status of leanness by fuzzy logic and comparison with other industry by selecting a benchmarking company.[23]
Bhim S et al 2010, India	Automobile	Provided a leanness measurement method on the basis of different parameters like issues of suppliers, lean practices, various non-value added activities, and issues of customers with the help of fuzzy set theory.[5]
Behrouzi F et al. 2010, Iran	Automobile	Formed a framework to estimate the leanness level of supplier's performance based on JIT, waste elimination, and cost reduction using fuzzy.[17]
Zanjirchi S M et al. 2010, Iran	Tile and Ceramic	Developed a methodology to know the status of leanness of a system using human perceptions based on fuzzy logic.[47]
Behrouzi F and Wong K Y 2011, Malaysia	Manufacturing	Presented a quantitative model to assess the lean performance based on lean attributes such as JIT and waste elimination with fuzzy membership functions.[16]
Vinodh S and Balaji S R 2011, India	Modular switches mfg.	Designed a DSS to assess degree of leanness using five Parameters and twenty criteria with fuzzy logic.[45]
Vinodh S and Vimal K E 2012, India	Transformers Manufacturing	Developed a theoretical Model using five enablers and thirty criteria to find the level of leanness with the help of fuzzy logic.[44]
Anvari A et al. 2012, Iran	Manufacturing	Developed a methodology to assess the impact of lean by considering the parameters lead time, cost, defects, and value with fuzzy approach.[1]
Behrouzi F and Wong KY 2013, Iran	Automotive Industry	Established a model to check leanness status for supply network of SME.[15]
Matawale C R 2014, India	Locomotive	Measured the leanness using five Parameters and thirty criteria with the

	part mfg.	trapezoidal fuzzy set.[11]
Pakdil F and Leonard KM 2014, Turkey		Developed a leanness measure tool to use qualitative and quantitative measures with fuzzy logic.[18]
Matawale C R et al. 2015, India	Automobile part mfg.	Developed a system to estimate the level of leanness for supply chain in an organisation with trapezoidal fuzzy numbers.[9]
Maasouman MA and Demirli K 2016, Canada	Manufacturing	Developed a lean model to check the status of implemented lean strategies on the basis of people, management of facilities, working conditions, manufacturing processes, JIT, and leadership with the help of fuzzy.[27]
Vidyadhar R et al. 2016, India	Manufacturing	Presented a theoretical model to find the level of leanness by fuzzy logic.[40]
Agrawal R et al. 2017, India	SME	Used the combination of fuzzy logic and ANFIS to assess the leanness using different Parameters and criteria.[38]
Narayanamurthy G and Gurumurthy A 2018, India	Healthcare	Developed a scientific model to check the status of leanness using fuzzy logic.[19]
Deshmukh Y P and Borade A B 2019, India	Thermo--forming	Presented a fuzzy based model to assess the performance of lean tools based green supply chain.[56]
Wankhede V A et al. 2019, India	Manufacturing	Assessed the degree of leanness of SME by fuzzy logic approach.[49]
Saleeshya P.G. and Binu M 2019, India	Telecom equipment mfg.	Presented a neuro fuzzy model to assess the leanness of a telecom equipment manufacturing industry.[34]
Bidhendi S S et al. 2019, Australia	Modular manufacturing	Proposed a weighted leanness assessment model to measure overall leanness score by Fuzzy-ANP approach.[41]
Domínguez L P et al. 2019, Mexico	Automotive company	Assessed the lean manufacturing performance and prioritised the different criteras by Hesitant Fuzzy and TOPSIS.[22]
Kumar N et al. 2019, India	FMCG	Assessed the leanness of a FMCG industry which was using lean manufacturing by fuzzy logic approach.[30]
Dahda SS et al. 2020, Indonesia	Steel Processing	Determine the leanness level of the industry on the basis of four dimensions which are Quality, process, human resource and delivery supplier by Fuzzy logic.[42]
Suresh M and Vaishnavi V 2020, India	Healthcare	Proposed a conceptual model to measure the leanness of a hospital by fuzzy logic.[28]
Tayaksi C et al. 2020, Turkey	Plastic Industry	Presented a conceptual framework for leanness assessment by Fuzzy DEMATEL approach.[12]

Table 3: Literature Review on Different Parameters

Parameters →		**Management Responsibility (MR)**	**Manufacturing Management (MM)**	**Work Force (WF)**	**Technology (T)**	**Manufacturing Strategy (MS)**
Authors	**Year**					
Hins P et al.[35]	1998	*	*	*	√	*
Ramaswamy et al.[31]	2002	*	*	√	*	*
Doolen TL, Hacker[48]	2005	*	√	√	*	*
Achanga et al.[33]	2006	√	*	√	*	*
Lin CT et al.[8]	2006	*	*	√	√	*
Kumar M et al.[26]	2009	√	*	√	*	*
Hines P et al.[36]	2010	*	*	√	*	*
Singh B et al.[5]	2010	*	*	√	√	*
Singh B et al.[6]	2010	*	*	√	√	*
Vinodh S, Balaji SR[45]	2011	√	√	√	√	√
Vinodh S, Chintha [46]	2011	√	√	√	√	√
Vinodh S, Vimal K[44]	2012	√	√	√	√	√
Vinodh S, Joy D[43]	2012	√	√	√	√	√
Panizzolo R et al.[39]	2012	√	*	√	*	*
Timans W et al.[53]	2012	*	*	√	*	*
Dora M et al.[24]	2013	*	*	√	*	*
Vimal K, Vinodh S[21]	2013	√	√	√	√	√
Matawale C R[11]	2014	√	√	√	√	√

Rose et al.[4]	2014	√	*	*	*	*
Wong et.[54]	2014	*	*	*	√	*
Matawale C R et al.[9]	2015	√	√	√	√	√
Azadeh et al.[2]	2015	√	√	√	√	√
Mangalgi P, Hosalli [37]	2015	√	√	√	√	√
Vidyadhar R et al.[40]	2016	√	√	√	√	*
Elnadi M, Shehab E.[25]	2016	√	*	√	*	*
Agrawal R et al.[38]	2017	*	√	√	*	√
Yadav V et al.[52]	2018	√	*	√	*	*
Wankhede V et al.[49]	2019	√	*	√	√	√
Saleeshya P, Binu [34]	2019	√	*	√	*	*
Kumar N et al.[30]	2019	√	√	√	√	√
Suresh, Vaishnavi [28]	2020	√	*	√	√	*
Tayaksi C et al.[12]	2020	√	*	√	*	*

3. RESEARCH GAP AND OBJECTIVES

We have found only eight papers from different data base like Google scholar and Science direct regarding leanness assessment in food processing industry. In three papers, authors have calculated the leanness of food industry with the help of pilot survey from different industry by sending questionnaire. There is only one paper from Indian food industry which is related to increase the leanness of food industry. There are two authors who have calculated the leanness of food industry with the help of AHP and balance score card by considering only few parameters. Seventeen authors have calculated the leanness of mostly automobile and manufacturing industries on the basis different Parameters and criteria. So there is less work on leanness assessment of food processing industry. There are no work to assess leanness of whole food industry with fuzzy logic on the basis of different Parameters and different criteria.

The main finding of this work is the Assessment of leanness and comparison of leanness index (LI) by fuzzy logic for the selected organisations. This paper meets the following objectives:

- To calculate the leanness of Indian food processing industries with fuzzy logic.
- To compare the leanness index of Indian food industries.
- To find the weak areas of Indian food industries.
- To find out common maximum beneficial lean practices.
- To suggest lean techniques to improve weak area or to increase leanness of industries.

4. RESEARCH METHODOLOGY ADOPTED

Flow of this work in this paper is according to fig 2. To assess the system leanness or whole enterprises leanness five Parameters has been chosen from the literature which are mentioned in 27 research papers by different authors as in table 3. After that, different sub parameters selected. Then these sub parameters has been divided into different attributes which are in question form in questionnaire. The questionnaire was developed on five likert scale based on these Parameters and sub parameters. We have received responses for performance rating of all attributes and weightage of different Parameters, sub parameters and all attributes from different designation personals like management representative (MR), incharge, and supervisor of bread manufacturing industry. We requested to choose an appropriate value in linguistic terms based on their experience with the organisation to them. We received responses from different personnel of Rusk and noodles manufacturing industry also which are followings manager admin, quality officer, production manager, purchase officer and lab incharge. Received qualitative responses have been converted into quantitative terms according to fuzzy triangular numbers. Industry leanness index (ILI) has been calculated with fuzzy operations. To find the leanness level of both industries, ILI has been compared with standard lean levels. After that, exact location of ILI has been found mathematically using Euclidean equation. Performance Importance Score (PIS) and Ranking Score have been calculated also to identify weak areas for improvement.

5. CASE STUDY

India has second place in most populated countries with a population of 1.35 billion. GDP growth of India is expected 6.5 % in Year 2021-2022. Indian economy is fifth largest economy in the world. It is moving towards to become the third largest economy of the world. Indian food market has sixth place in the world. The food processing sector covers 32% of the total food market of country. Food processing covers 13% of total exports of country. There are 37,175 registered food processing industries in India. Approximately 1.7 million people are working in Indian food and beverage industries. There are good growth and more profit in this sector due to increased domestic consumption day by day. There are different category of food processing industries like Baked Goods, Baby Food, Confectionery, Biscuits and Snack

Bars etc. Nestle, Britannia, Amul, Parle, Haldiram, and ITC are the top food industries.

For this case study we have worked in two Indian food processing industries. One is Bread manufacturing which is certified with ISO and FSSAI. This industry has been availing the benefits of lean techniques like 5S, TQM, TPM, and JIT. Responses have been received by visiting the plant and with the help of discussion with different personals. Permission had been given to visit the plant for a month by the Director of the concerned industry. Ten questionnaires were filled from different persons of industry to avoid biasness. Then these questionnaires have been converted into single one by considering average responses. Second one is Rusk, Toast, and noodles manufacturing industry which is certified with ISO, FSSAI, US FDA, HALAL and BRC. This Case Industry has been used Lean concept practices since 3 year and 6 months. Both are located in Sonepat, Haryana, India. Top level manager gave us time for meeting regarding permission to visit the plant. In meeting, Company Manager refused to give permission for visit the plant for a week due to the construction work and busy schedule of company employees. Company manager introduced us to another senior staff member to fill the questionnaires. Three questionnaires were filled that time. After a week, a second visit of industry was done to collect other four questionnaire copies from respondents. These seven questionnaires have been converted into one by considering average responses.

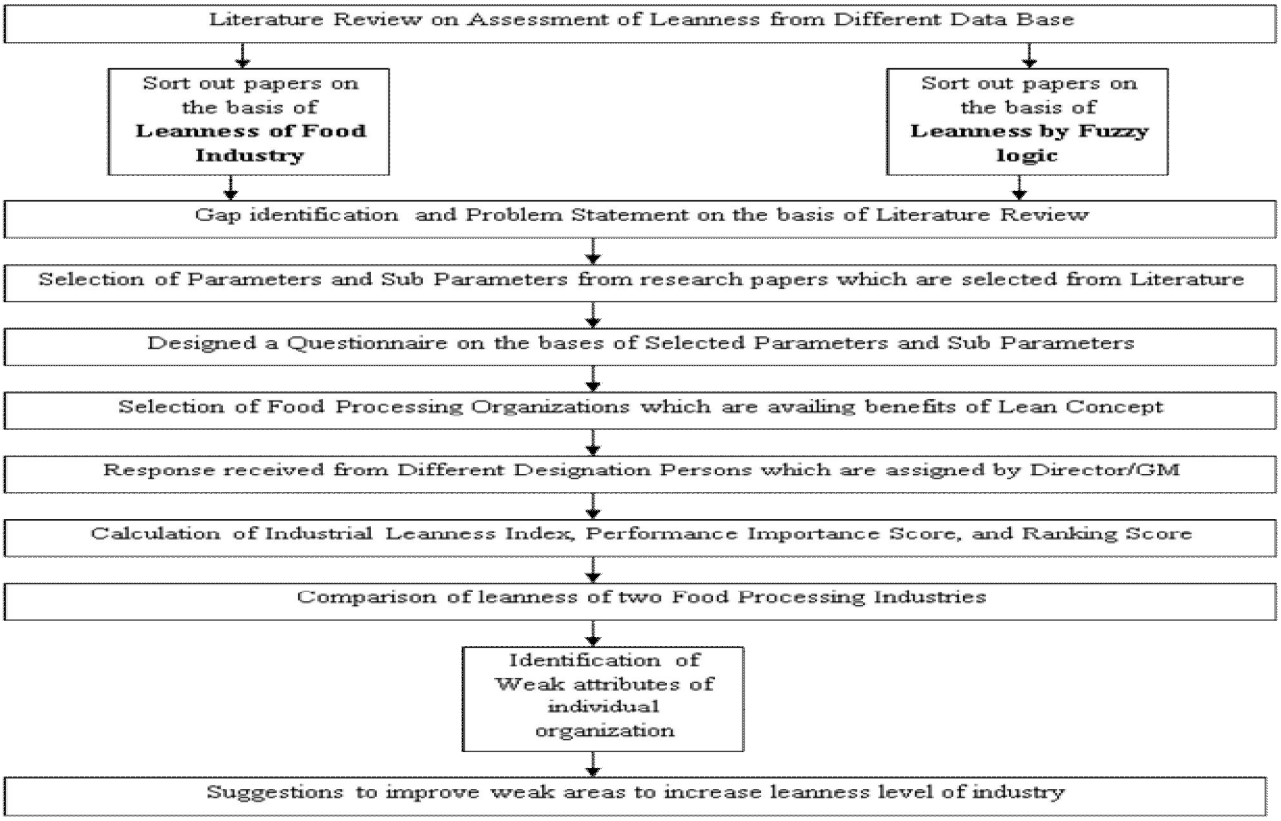

Figure 2: Research Work Flow

6. RESULTS AND DISCUSSIONS

Response was received for first case company from different designations persons which are following Management Representative (MR), Incharge, Production Supervisor, Hygiene Supervisor, and Engineers. Responses have been also received for second case company from Production Head, Administrative Head, Quality Head, Sale and purchase Head, Engineers and lab In-charge after the conversation on leanness measurement separately. These persons of both industries assigned rating of all attributes and gave weightage to Parameters, sub parameters and all attributes. After that we took average of the responses due to small sample for each company. These received Qualitative responses replaced with fuzzy numbers which is displayed in following table 4. Leanness of Parameters, sub parameters and attributes is calculated by following equation (1).

$$LI = \sum_{i=1}^{N} \frac{(R_i \times W_i)}{W_i} \qquad (1)$$

Table 4: Fuzzy triangular numbers for Qualitative terms

Rate				Weight			
Qualitative terms	**Fuzzy Number**			**Qualitative terms**	**Fuzzy Number**		
Poor	0	0	2.5	Very Low	0	0	0.25
Fair	0	2.5	5	Low	0	0.25	0.50
Good	2.5	5	7.5	Medium	0.25	0.50	0.75
Very Good	5	7.5	10	High	0.50	0.75	1
Excellent	7.5	10	10	Very High	0.75	1	1

Where R_i = Index of Performance for Parameters as variation of I, W_i = Weightage of Importance for Parameters as variation of i. LI = Leanness Index. Example calculation of lean index for one sub parameter is shown below:

$$LI_{22} = \frac{\begin{bmatrix}(0,0.25,0.5)\otimes(0,2.5,5)\oplus\\(0,0.25,0.5)\otimes(0,2.5,5)\oplus\\(0,0.25,0.5)\otimes(0,2.5,5)\oplus\end{bmatrix}}{\begin{bmatrix}(0,0.25,0.5)\oplus\\(0,0.25,0.5)\oplus\\(0,0.25,0.5)\end{bmatrix}}$$

For case company I LI_{22} = [0, 2.5, 5] and same as for case company II [5, 7.5, 10]. Where LI_{ij} = Lean Index of sub Parameters as variation of i and j, R_{ijk} = Rate of Performance of Attribute as variation of i, j, and k, W_{ijk} = Weightage of importance of Attribute as variation of i, j, and k. Lean Index (LI) for all sub parameters of both case companies has been calculated which is shown in table 5.

Table 5: LI for all sub parameters

LI	Case company I	Case company II
LI_{ij}	R_{ij}	R_{ij}
LI_{11}	(2.5, 5, 7.3)	(4.64, 7.05,9.5)
LI_{12}	(2.97, 5.38, 7.85)	(5, 7.5, 10)
LI_{21}	(5, 7.5, 10)	(5, 7.5, 10)
LI_{22}	(0, 2.52, 5)	(5, 7.5, 10)
LI_{23}	(5, 7.5, 10)	(5, 7.5, 10)
LI_{24}	(2.52, 4.5, 6.88)	(5, 7.5, 10)
LI_{31}	(4.2, 6.5, 8.64)	(5, 7.5, 10)
LI_{32}	(3.76, 5.45,7.69)	(5, 7.5, 10)
LI_{41}	(2.5,5, 7.51)	(5, 7.5, 10)
LI_{42}	(5, 7.5, 10)	(5, 7.5, 10)
LI_{43}	(4.17, 6.25, 8.6)	(4.58, 6.88, 9.32)
LI_{51}	(6.5, 8.9, 10)	(5, 7.5, 10)
LI_{52}	(5, 7.5, 10)	(5, 7.5, 10)

Example calculation of lean index for one parameter is shown below

$$LI_1 = \frac{\begin{bmatrix}(0.25,0.5,0.75)\otimes(2.5,5,7.3)\oplus\\(0.25,0.5,0.75)\otimes(2.97,5.38,7.85)\end{bmatrix}}{\begin{bmatrix}(0.25,0.5,0.75)\oplus\\(0.25,0.5,0.75)\end{bmatrix}}$$

For case company I LI_1 = [2.74, 5.19, 7.58] and same as for case company II [5, 7.4, 9.82]. Where W_{ij} = Weightage of importance of sub parameters as variation of i and j, R_{ij} = Rate of Performance of sub parameters as variation of i and j. LI_i = Lean Index of Parameters as variation of i. Lean index (LI) for all Parameters of first case company has been calculated which are followings LI_1 = (2.74, 5.19, 7.58), LI_2 = (4.5, 6.28, 8.51), LI_3 = (3.98, 5.98, 8.16), LI_4 = (4.17, 6.43, 8.8), and LI_5 = (6.13, 8.43, 10). Lean index (LI) for all Parameters of second case company has been calculated which are followings LI_1 = (4.82, 7.28, 9.75), LI_2 = (5, 7.5, 10), LI_3 = (5, 7.5, 10), LI_4 = (4.86, 7.29, 9.77), and LI_5 = (5, 7.5, 10). Industrial leanness index (ILI) of both case companies has been calculated which given below

$$ILI = \frac{\begin{bmatrix}(0.25,0.5,0.75)\otimes(2.74,5.19,7.58)\oplus\\(0.25,0.5,0.75)\otimes(4.5,6.28,8.51)\oplus\\(0.25,0.5,0.75)\otimes(3.98,5.98,8.16)\oplus\\(0.25,0.5,0.75)\otimes(4.17,6.43,8.8)\oplus\\(0.50,0.75,1)\otimes(6.13,8.43,10)\end{bmatrix}}{\begin{bmatrix}(0.25,0.5,0.75)\oplus\\(0.25,0.5,0.75)\oplus\\(0.25,0.5,0.75)\oplus\\(0.25,0.5,0.75)\oplus\\(0.50,0.75,1)\end{bmatrix}}$$

ILI of the case industry I, ILI = [4.61, 6.64, 8.69], ILI of the case industry II, ILI = [5, 7.5, 9.96]. To identify the level of leanness for first case company, this mathematical calculated ILI is compared graphically with standard lean levels which are followings Poor Lean = (0, 1.5, 3), Fair Lean = (1.5, 3, 4.5), Lean = (3.5, 5, 6.5), High Lean = (5.5, 7, 8.5), and Excellent Lean = (7, 8.5, 10) which is shown in fig. 3 and same shown for second case company in fig 4. Graphical representation of leanness level has been drawn with the help of MATLAB. The closeness of calculated leanness level of case companies to standard leanness levels found mathematically with the help of Euclidean Equation (2).

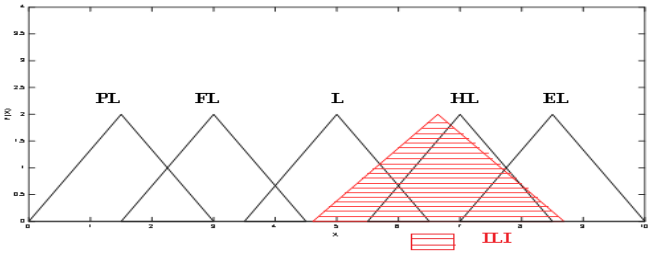

Figure 3: Leanness level of case industry I

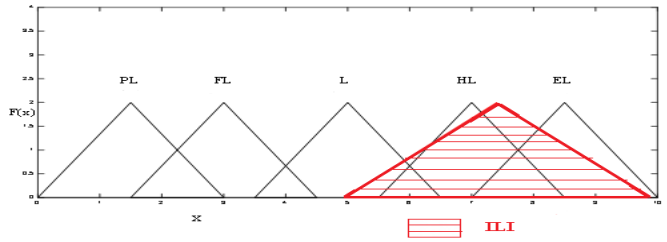

Figure 4: Leanness level of case industry II [30]

$$D(ILI, LL_i) = \sqrt{\left\{\sum_{xep}\left(f_{ILI}(x) - f_{LLi}(x)\right)^2\right\}} \quad (2)$$

Where D (ILI, LL_i) = Distance between ILI and standard lean level, LL_i = Fuzzy number for standard lean level, f_{ILI} (x) = Fuzzy numbers of Industrial Leanness Index, f_{LLi} (x) = Fuzzy numbers of standard leanness levels. x = lower, middle and upper triangular numbers.

$$D(ILI, HL) = \sqrt{\left\{(4.61-5.5)^2 + (6.64-7)^2 + (8.69-8.5)^2\right\}} = 0.98$$

It means Distance of ILI from High Lean = 0.98, Similarly, Distance of ILI from Lean = 2.95, Distance of ILI from Extreme Lean = 3.29, Distance of ILI from Fair Lean = 6.36, Distance of ILI from Poor Lean = 8.95. It means Industrial Leanness Index (ILI) triangle is lie between lean and high lean. And it is less than but nearer to High lean. Same procedure for case company II, Distance of ILI from High Lean = 1.56, Distance of ILI from Extreme Lean = 2.34, Distance of ILI from Lean = 4.4, Distance of ILI from Fair Lean = 7.77, Distance of ILI from Poor Lean = 10.34. It means Industrial Leanness Index ILI triangle of case company II is lie between high lean and excellent lean. And it is more than but nearer to High lean. Then all PIS of every attributes were calculated by using Equation (3).

$$PIS_{ijk} = W'_{ijk} \otimes R_{ijk} \quad (3)$$

Where $W'_{ijk} = \left[(1,1,1) - W_{ijk}\right]$

PIS = Performance Importance Score, PIS_{ijk} = PIS for ith parameter jth sub parameter ijkth attribute.Example of PIS calculation of one attribute is shown below:

$$PIS_{116} = (0.5,0.75,1) \otimes (2.5,5,7.5)$$

For case company I, PIS_{116} = (1.25, 3.75, 7.5). PIS of all attributes for both case industries were calculated with same procedure is shown in table 6. After that we have calculated Ranking Score (RS) with the help of calculated PIS using Equation (4).

$$\text{Ranking Score} = \frac{a + 4b + c}{6} \quad (4)$$

Example of Ranking Score calculation for one attribute of first case company is shown below:

$$\text{RankingScore of attribute116} = \frac{1.25 + 4 \times 3.75 + 7.5}{6} = 3.96$$

The ranking Score (RS) of all attributes are shown in table 6.

Table 6: Performance Index Score (PIS) and Ranking Score (RS) for both case Industries

LI	Case Industry I		Case Industry II			Case Industry I		Case Industry II	
LI_{ijk}	PIS	RS	PIS	RS	LI_{ijk}	PIS	RS	PIS	RS
LI_{111}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{246}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{112}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{311}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{113}	(0,0,2.5)	0.42	(0,1.88,5)	2.09	LI_{312}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{114}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{313}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{115}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{314}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{116}	(1.25,3.75,7.5)	3.96	(0.63,2.5,5.63)	2.71	LI_{315}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{117}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{316}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{118}	(0.63,2.5,5.63)	2.71	(0.63,2.5,5.63)	2.71	LI_{317}	(0,0,2.5)	0.42	(0,1.88,5)	2.09
LI_{121}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{321}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{122}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{322}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{123}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{323}	(0,1.88,5)	2.09	(1.25,3.75,7.5)	3.96
LI_{124}	(0,1.25,3.75)	1.46	(0,0,2.5)	0.42	LI_{324}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{125}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{325}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{126}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{326}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{127}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{327}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{128}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{328}	(0,1.88,5)	2.09	(1.25,3.75,7.5)	3.96
LI_{129}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{329}	(0,1.88,5)	2.09	(0,1.88,5)	2.09

LI_{211}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{411}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{221}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{412}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09
LI_{222}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{421}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{223}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{431}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{231}	(0,1.88,5)	2.09	(0,0,2.5)	0.42	LI_{432}	(0.63,2.5,5.63)	2.71	(0,0,2.5)	0.41
LI_{241}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{433}	(1.25,3.75,5)	3.54	(0.63,2.5,5.63)	2.71
LI_{242}	(0,1.88,5)	2.09	(0,1.88,5)	2.09	LI_{511}	(0,0,2.5)	0.42	(0,1.88,5)	2.09
LI_{243}	(0.63,2.5,5.63)	2.71	(0,1.88,5)	2.09	LI_{512}	(0,1.88,5)	2.09	(0,1.88,5)	2.09
LI_{244}	(0.63,2.5,5.63)	2.71	(1.25,3.75,7.5)	3.96	LI_{521}	(1.25,3.75,7.5)	3.96	(0,1.88,5)	2.09
LI_{245}	(0.63,2.5,5.63)	2.71	(1.25,3.75,7.5)	3.96					

After discussion with industry personals, scale three was set to identify the weak attributes. Attributes which have RS higher than three are weak attributes which are followings LA_{116} = A good knowledge of all employees about Lean tools/ techniques, LA_{433} = Lean is useful to remove or reduce all seven industrial wastes, LA_{521} = Proper utilization of all material and available resources for first case company. And LA_{244} = Continuous improvement process for better quality, LA_{245} = Good systematic layout for the production, LA_{323} = Smooth Information flow, and LA_{328} = Workers work to eliminate or reduce waste in ongoing fashion for second case company. Seventeen attributes are common for both case companies having same ranking score which are followings LA_{118} = Top management provides suitable budget for improvement in workers safety, their training, and other various resources for higher industrial output, LA_{128} = Effective role of management for Lean implementation, LA_{211} = Value Stream mapping (VSM) provides a smooth material and information flow in whole company, LA_{221} = Value Stream mapping (VSM) is a combination of different visual management process, LA_{222} = Visual boards on the shop floor for key information of processes, LA_{223} = Inventory control is very important to improve process quality, LA_{241} = TPM reduced growth rate of failure/accident in industry, LA_{242} = Industry follows different quality standards on international floor, LA_{311} = Demonstrating the need of Lean manufacturing for the welfares of the employees, LA_{312} = Few status dissimilarities between top management and workers to make highly empowered work atmosphere, LA_{313} = Creations of cross-functional teams within the organisation, LA_{322} = Lean implementation creates disturbance in industry, LA_{324} = Employees are Key to problem solving in industry, LA_{329} = Organisation takes care of the employees, LA_{421} = Involvement of Employees in writing policies and procedures in favour of workers, LA_{431} = Identify non value added activities (NVAA) with lean tools/ techniques, and LA_{512} = Effect of Lean tool/techniques on NVAA. Lean Strategies which are used by first case company are 5S, TQM, TPM, and JIT. . Lean Strategies which are used by second case company are 5S, TQM, TPM, Kaizen, Automation, Six Sigma, Total employee involvement (TEI), and Statistical process control (SPC).

7. SUGGESTIONS TO IMPROVE WEAK AREAS

For improvement in leanness level, training of all employees should be organised in slots or groups to increase the knowledge about lean strategies. Participation of all employees should be compulsory during the implementation of new lean tools/ techniques. Implementation of these kinds of strategies should be in effective way to remove or reduce all industrial wastes. Cellular manufacturing is capable to construct the proper plant layout for maximum usage of available resources. For improvement in leanness level, there is need to focus more on implemented Kaizen and six sigma lean tools for continuous improvement for better quality. Cellular manufacturing is the best lean tool which is capable to construct the systematic plant layout for production. Visual factory is best lean tool for smooth information flow for all. Visual indicators, visual displays and visual controls should be used to improve communication of information. There should be some schemes to encourage the workers for reduction of wastes.

If any company uses maximum lean strategies as per their need and also implement these strategies in effective way the leanness level of that company automatically will be high. First case company used few lean strategies so leanness level of this company is lie between lean and high lean. Second case company used lean strategies more than first case company so leanness level of this company is lie between high lean and extremely lean which is higher than first case company. Second case company produce the products of international standards of high quality for export by using automation but first case company produce products for domestic use and have less budget to invest on latest technologies as compare to second case company. Second case company focuses mainly on quality but first case company focuses on sale and higher production.

8. FUTURE SCOPE

This work is for only two bake industries. We can calculate leanness level of another type of food industries like soft drink, energy drinks, meat industry, and agriculture based industries. We can calculate leanness of many food industries according to their performance parameters because every

company have own performance measurement parameters like one consider only profit another consider only quality. So parameters vary according to industries.

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