

## **Fuzzy Logic Model for Evaluating Leanness of Employee Behaviour Index in Lean Organization**

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### **Abstract**

In the context of globalization, organizations are practicing Lean Principles to meet the competitive market. The need for employee culture in Lean organization is different from traditional manufacturing. The concept of Lean is primarily applied to eliminate wasteful activities and improve upon value added activities in an organization. The literature shows evidence that many organizations fail to sustain Lean Practices due to their employees' fat behaviour that do not add any value to the organizations. The organization should develop a culture of continuous learning, practice new skills and lean behaviours. The success and growth of an organization depends on right human resource with right behaviours. The employee evaluation is a continuous process in a growing organization starting from new recruitment to promotion of existing employee. The employer has to evaluate in terms of quantifiable index to rank, select, assign and promote the employees in an organization. This paper presents a methodology to evaluate the behaviour index of an employee by a simple index called Lean Behaviour index (LBI) and Fat Behaviour Index (FBI).

In the present research work a fuzzy logic model is formulated to evaluate the leanness of employee behaviour. Fuzzy Logic is used for the evaluation of subjective type attributes. The self awareness process to generate Lean Behaviour and eliminate fat behaviour was done. This model is applied to a manufacturing organization to evaluate the LBI and FBI for various levels of employees. This model can be horizontally deployed to institutions adopting Lean principles for an unbiased evaluation of leanness of employee behaviour.

## **1. Introduction**

The term LEAN Production was coined during the MIT Study [11]. Lean Thinking provides a way to do more with less resource, less human effort, less equipment, less time and less space. It creates value by elimination of waste. Since then, in the globalized competition a number of companies have started implementing lean principles. A few companies succeeded in the transformation but many of them failed to sustain Lean practices due to lack of right knowledge of Lean principles / tools, inadequate practicing skill on lean tools and poor attitude/ behaviour of employees. The Toyota Production System (TPS) [12] practiced fourteen management principles like Continual Learning Organization, Respect for People & Develop Exceptional People and Team work, etc., which made Toyota become a leader in automobile Industry.

In manufacturing activities waste is defined as actions that consume but do not add value to a product in the eyes of the customer. This concept of waste is extended to the behaviours of individuals and groups within the workplace. Emillani [4] defined the term "Lean Behaviours" as that which add or create value. It is the minimization of waste associated with arbitrary or contradictory thoughts and actions that leads to defensive behaviour, ineffective relationship, poor cooperation and negative attitude. He showed the tremendous amount of waste that normally exists in intra and interpersonal relationships. It is harder to recognise and difficult to quantify. Lean behaviour in an organisation / institution involves saying or doing what needs to be said or done at the right time, in the right way, for the right purpose, to the right person(s). Fat behaviours are defined as behaviours that add no value and can be eliminated or cannot be avoided. Emillani [5] in his paper "Continuous Personal Improvement" showed how exact lean tools that are used to improve business process can also be used to improve leadership behaviour. He applied the five fundamental concepts of lean: Specify Value, Identify the Value Stream, Flow, Pull and Perfection, to develop lean behaviours that add value to the organisation. Emiliani [6] also showed how the beliefs, behaviors, and competencies of leaders skilled in the Lean management system are remarkably different and much better aligned with the favourable outcomes that managers seek. Eswaramoorthy et al [8] outlined on the basis of the survey that the reasons for low priority towards sustainable lean implementation is due to lack of effort required to change the attitude of workers. Eswaramoorthy et al [9] pointed out the importance of Lean behaviour issues in creating a lean culture in the organization. The behaviours of the employee should be tuned to meet the challenges required in the Lean manufacturing organisation. Mohanram et al [13] described the process of "Self awareness" as a key to generate Lean Behaviour that adds value to the organisation.

At present few tools are available to evaluate the attitude of people. In Big-Five (Self) [10], forty trait statements are used and participants are asked to describe as they see themselves in a nine point scale starting from extremely inaccurate to extremely accurate. The scoring sheet displays one's level in five areas, viz. Emotional Stability, Extraversion, Openness, Agreeableness and Conscientiousness. Myers-Briggs Typology Indicator (MBTI) [14] contains 72 statements and participants are to mark "yes or no" in response to the statement. It identifies

individuals’ 4-letter Myers-Briggs personality type code. Transactional Style Inventory [16] contains 36 randomly arranged statements. The participants are asked to indicate how much of it is true to one's behaviour by using a score from 0 to 5. TSI instrument is based on Transactional Analysis concepts of three ego states - Parent (Nurturing and Regulating), Adult and child (Adaptive, Reactive and Creative), and two Life Positions (OK and Not-OK).

Ching-Torng Lin et al [1] showed how fuzzy logic methodology can be effectively used for evaluation of organisation's agility. Vinodh et al [17] outlined methodology for evaluation of leanness of an organisation using fuzzy logic but no evaluation is done to the assessment of Lean / Fat Behaviour of an employee. The importance of lean behaviour in the focus of improvement in Lean Practice by Emiliani [4] is shown in figure 1. Hence there is a need to focus on industry requirements in terms of Lean Behaviour of employee and a methodology to assess in quantifiable terms, preferably in terms of an index. The table 1 shows typical Lean & Fat behaviours exhibited by the people in the organisation. Like classification of waste in the manufacturing Organisation, fat behaviours can also be classified into eight groups and they are shown in Table 2.



**Figure 1. Lean Practices**

**Table 1. TYPICAL Behaviours exhibited by the people in the workplace**

	Lean Behavior	FAT BEHAVIOR
1	Praise others for their good work	Do not appreciate others good things
2	Doing what they say	Saying one thing and doing other
3	Team work & active participation	Lack of Involvement No teamwork
4	Dialogue	Arguing about your point of view
5	Clarity on What to do & how to do	Confusion on what to do & how to do

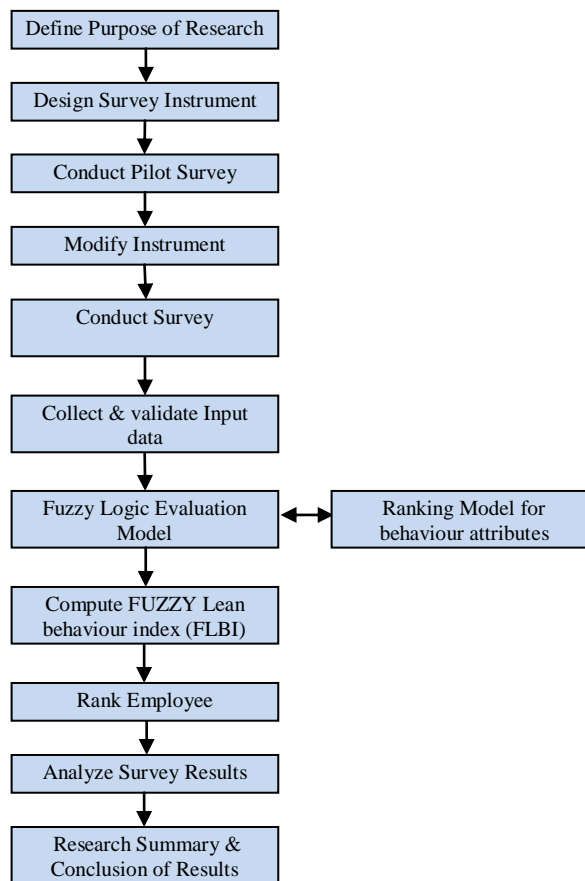
6	Admit mistake/errors committed & willingness to correct	Inability to admit errors/ mistakes & refusal to correct
7	Go by consensus	Thinking everybody should follow you
8	Ready to meet people & listen to them	Inaccessibility to people / information
9	Conclusions based on facts	Subjective conclusions
10	Co operation between people	Internal Politics among people

**Table 2. Classification of Eight types of Behaviour Waste - Fat Behaviours Attributes**

S. No	Waste Types	Waste Definition		Behavior Types
		Manufacturing	Behavior	
1	<b>Over production</b>	Producing more than customer order/ requirement	Behaviors that are present more than requirement that do not add value.	Talkative Favoritism Impatient
2	<b>Over processing</b>	Extra operations / processing beyond requirement that customer not willing to pay for	Unnecessary behaviors beyond requirement that do not add value	Gossip Criticism Unnecessary Commentary
3	<b>Defects/ Rework</b>	Product /services that contains defect / errors	Behavioral complaints that do not add value.	Revenge Blaming Others Negativity
4	<b>Inventory</b>	Any material/ parts not used by the customer.	Accumulated behaviors that do not add value.	Selfishness Ego Pride
5	<b>Motion</b>	Unnecessary movement of people / part within a Process without adding value.	Unnecessary habitual movements(mental & physical) within ourselves that do not add value	Confusion Bad Gestures Too many thoughts
6	<b>Waiting</b>	Waiting refers to the periods of inactivity. Idle people / equipment wait for other processes	Behaviors that lead to People / process waiting without adding value.	Lethargy Hesitate Inaction
7	<b>Transport</b>	Unnecessary movement / handling of materials without adding value.	Unnecessary behavioral movements (physical / mental) that do not add value	Roaming / Loitering Wandering Thoughts Unclear Goals &Expectation
8	<b>Untapped Human Potential</b>	People talent /knowledge not used in the value adding process.	People intra / interpersonal behaviors that do not add value.	Disrespect People Ignorance Non Involvement Of People

**2. Research Methodology**

The methodology followed for this research work is shown in figure 2. The purpose of the research work has been stated at first followed by the Survey instrument Design to collect the necessary data. Five point Likert scales [15] have been used to state the respondent's status with a minimum score of 1 and maximum score of 5 with equal interval of 1. A pilot study was conducted to test the validity of the instrument and modifications to the survey instrument were done based on the suggestions received from the industry experts. The target population was identified and the survey forms were sent for data collection. After the required data collection, necessary statistical validations were carried out for ensuring the usefulness and reliability of the data. A fuzzy logic model with necessary input / output format was formulated using MATLAB software for evaluation of Lean / FAT Behaviour Index. The importance weight for behaviour attributes was determined using the ranking model. Both Fuzzy Lean Behaviour Index (FLBI) and Fuzzy Fat Behaviour Index (FFBI) were computed based on the input data. The results were analyzed, research findings were summarized and concluded with recommendation for further work.



**Figure 2. Research Methodology**

## 2.1 Purpose of Research

Since human behaviours are important for effective implementation of lean principles, individuals at different levels in the organisation should be aware of their inter / intra relationship behaviour status, practice lean behaviours and monitor the progress in terms of an index. A simple methodology is needed for such evaluation. The purpose of this research is to develop a methodology to evaluate behaviour leanness in terms of an index called Lean Behaviour Index (LBI). Based on the above index, both ranking and gap analysis are to be done at both individual and organisation levels in order to focus on elimination of behavioural waste and generate lean behaviour for creating value to the organisation.

## 2.2. Survey Instrument Design

Flow in lean production means to carry out manufacturing process without any stoppage or delay by single piece flow process. In the context of Lean Behaviour flow means to behave in a manner that minimizes or eliminates delays or stoppages in the work performed by others. Cleary [2, 3] listed the selected lean behaviours that promote flow between people. The survey instrument was designed for evaluating select Lean Behavior attributes as given in table 3. The survey instrument design methodology is shown on figure 3.

**Table 3. Select Lean Behaviour Attributes**

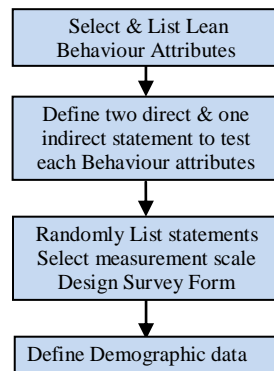
Self-awareness	Calmness	Consistency	Respect	Equanimity
Humility	Quietitude	Generosity	Listening	Objectivity
Compassion	Reflection	Patience	Observation	Discipline
Balance	Honesty	Humor	Trust	Wisdom
Deference	Benevolence	Understanding	Sincerity	Rectitude

**Table 4. Lean Behaviour attribute statements**

Type	Statement For Lean Behavior "Honesty"
Direct	When I pick up a cell phone lying on the road, I try to locate the owner.
Direct	I promptly return the extra money handed over by a sales clerk
Indirect	I do not mind taking the credit for my friend's task

**Table 5. Random Index for attribute statement – Sample**

Attribute	1	2	3	4	5	6	7	8	9	10
DQ1	18	27	3	69	41	65	47	72	26	66
DQ2	60	48	52	32	20	40	62	34	59	25
IQ1	33	28	17	68	57	12	2	46	55	5



**Figure 3. Survey Instrument Design**

<p><b>Part 1L</b>                  Read each statement given below and indicate on the right hand blank space how you behave this way by using the following guidelines.  <b>1 - Never 2-Rarely 3-Sometimes 4-Frequently 5-Always</b>                  Note: • There is no right or wrong answers.                  • Please respond as you actually behave, not as you would like / want to behave                  * Give your frank answer to reflect your style and it is for your benefit</p>							
			Never	Rarely	Sometimes	Frequently	Always
S.NO	STATEMENT	Score	1	2	3	4	5
1	I do not care to remember my personality trends		o	o	o	o	o
2	I stop at a red light even at midnight.		o	o	o	o	o
3	In the group photographs I prefer to stand at the back row.		o	o	o	o	o

**Figure 4. Survey Form for Lean Behaviour**

Statements related to the attribute were prepared and participants were asked to rate their status corresponding to the statement. For each attribute two direct statements (DQ1 & DQ2) and one indirect statement (IQ1) were prepared. Direct & indirect statements for evaluation of behaviour attribute "Honesty" is shown in table 4. A five point Likert scale with the value "1 to 5" was used to input the respondent's position with respect to the listed statements. A total of 75 statements were prepared and arranged randomly in excel sheet having sl. no. from 1 to 75. A matrix was formulated in excel file to group the responses for 75 statements in 25 Lean attributes. The indirect statement score was converted to direct score and the scores were entered in the matrix attribute wise. For example, the attribute in the serial no.1 namely "Self awareness" will have direct statement sl. no 18 & 60 and indirect statement sl. no. 33. This data was entered in the matrix and used as an input for the Fuzzy Logic evaluation model. The survey form shown in figure 4 is self explanatory that can be filled by the participants taking part in the survey. The survey instrument was administered to the Lean practitioners.

### 2.3. Statistical Validation

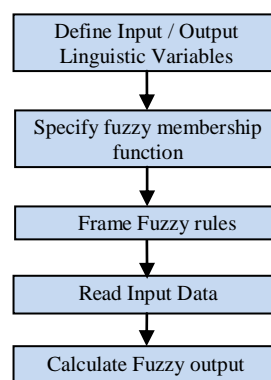
Both construct validity & reliability of data were conducted from the data collected from the respondents.

The face & content validity of the survey is of primary importance to determine the relevance of the survey form with the purpose of the research. Both industry & academic experts on Lean practice were consulted for the face & content validity of the survey instrument and research methodology. Based on their feedback, modification was done and survey instrument was administered to the Lean Practitioners for the pilot study. Based on the pilot study results, survey instrument was modified for final form. This final instrument was administered in the survey to collect data for evaluation of Lean Behavior Index.

Followed by the face & content validity, data reliability is important to check the internal consistency of data collected. Cronbach's alpha coefficient reflects the reliability of the data. By using SPSS 18.0 (Statistical Package for Social Sciences) software Cronbach's alpha coefficient was estimated for the data collected. Coefficient of 0.820 was obtained from the analysis of data which meets the minimum requirement of 0.7. It may be concluded that the data collected from the survey were reliable and could be used for further analysis [9].

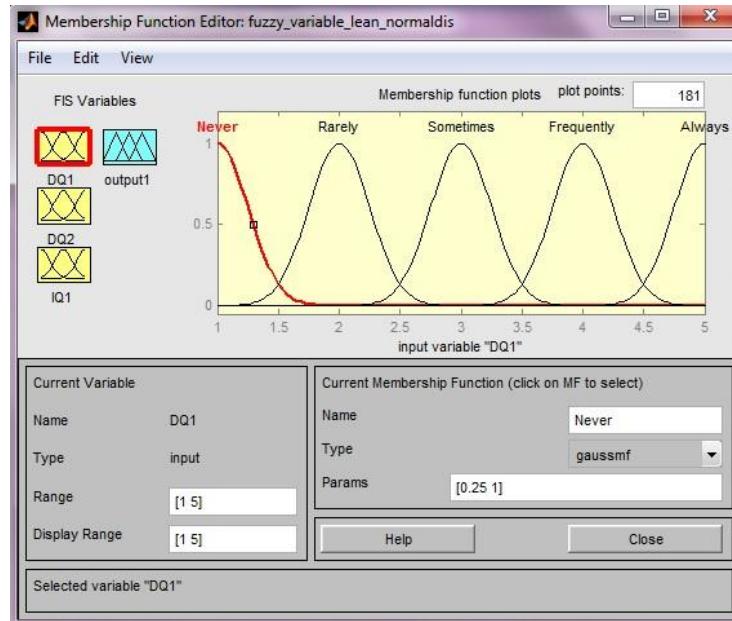
### 3. Fuzzy Logic Evaluation Model

A fuzzy based methodology was used to represent the imprecise, vague and ambiguous behaviour attributes. Figure 5 shows the steps involved in the fuzzy model. A fuzzy set is a set without a crisp value and defined by a boundary values. In this evaluation model a fuzzy set was defined by membership function. In this set the general linguistic terms such as " Never", "Rarely", "Sometimes", "Frequently" and "Always" were used to represent a range of values from 1 to 5. Both inputs & outputs were defined by the same linguistic values.



**Figure 5. Fuzzy Logic Evaluation Model**





**Figure 6. Fuzzy Logic Tool Box for Lean Behaviour Index**

Figure 6 shows the fuzzy model structure with input & output parameters. A normal membership function as shown in figure 7 was used to define the behaviour attributes. A standard deviation of 0.25 is taken with a mean value of 1 to 5 with corresponding fuzzy variables. Each attribute was evaluated through three statements DQ1, DQ2 and IQ1. The figure 7 shows the fuzzy membership function for input DQ1. The data input format for the model is shown in Table 6. The model provides an option by way of switch to include/exclude the required behaviour in the model. The output is based on fuzzy rules defined in the model. Fuzzy rules were framed to output the model from the input satisfying the conditions. Twenty five nos. of "IF... THEN" rules were included in the model and are shown in figure 8. The rule viewer for all included rules is shown in figure 9.

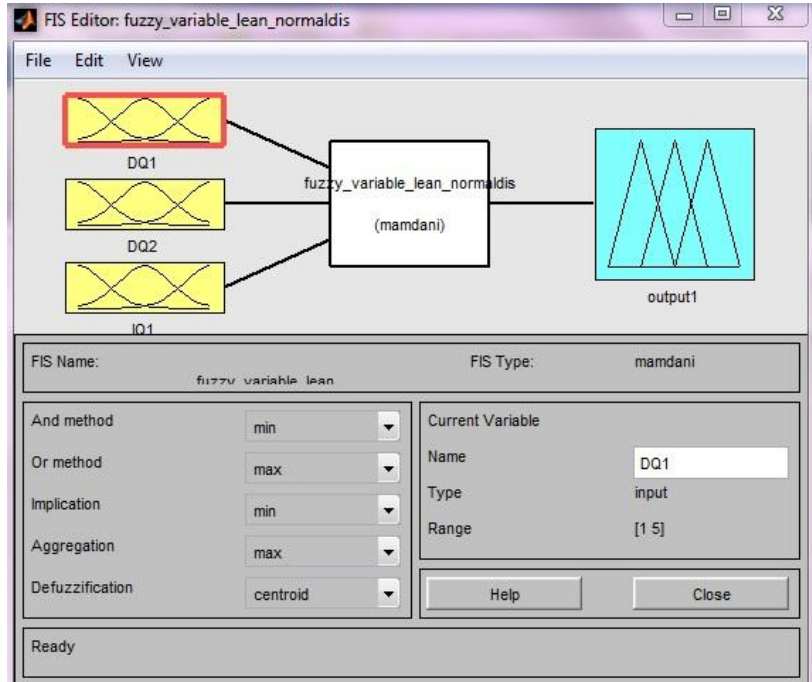


Figure 7. Membership function Editor for INPUTS & OUTPUTS

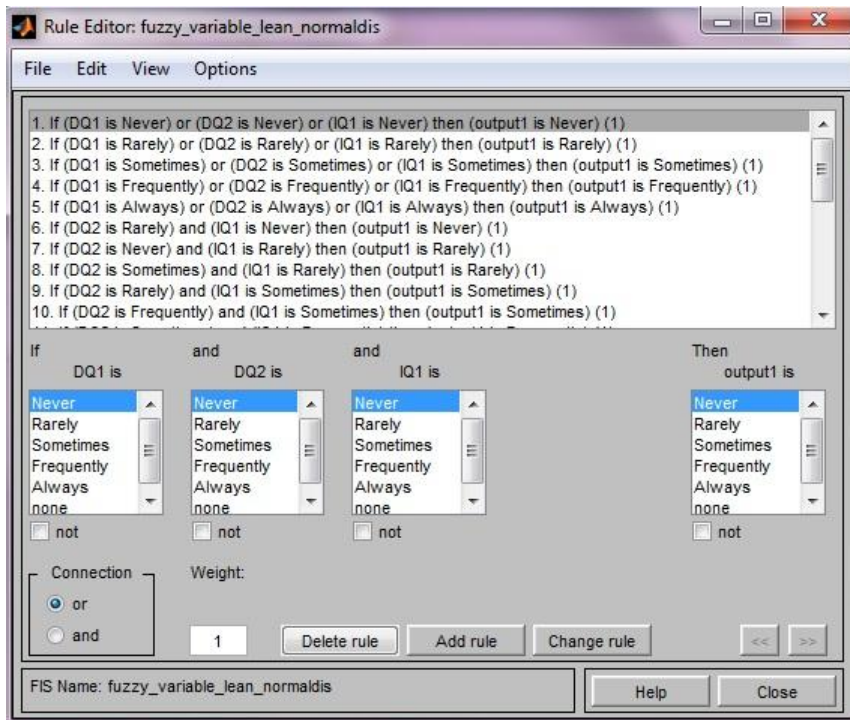


Figure 8. Fuzzy Logic Process Rule Editor

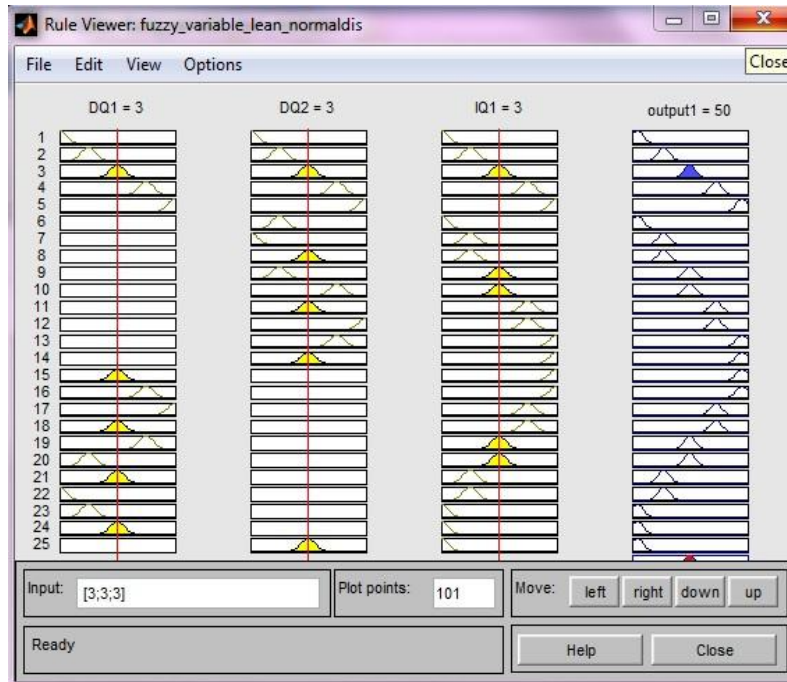


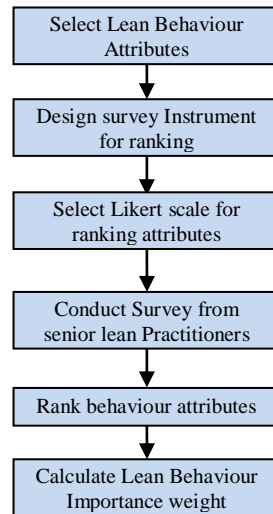
Figure 9. Fuzzy Rules Viewer

Table 6. Input data for Fuzzy Model

Code	101-L			INPUT			OUTPUT
S.no.	SO	WT	Behaviour	DQ1	DQ2	IQ1	INDEX
1	1	0.04	Self-	3	5	5	71.3
2	1	0.04	Humility	5	3	2	59.2
3	1	0.04	Compassion	4	3	4	56.7
4	1	0.04	Balance	5	5	4	84.0
5	1	0.04	Deference	5	5	5	94.4
6	1	0.04	Calmness	3	5	4	68.4
7	1	0.04	Quietitude	5	4	2	62.2
8	1	0.04	Reflection	3	5	3	71.0
9	1	0.04	Honesty	5	5	5	100.0
10	1	0.04	Benevolence	5	2	3	61.0
11	1	0.04	Consistency	3	4	2	47.3
12	1	0.04	Generosity	4	2	2	56.1
13	1	0.04	Patience	2	5	3	56.9
14	1	0.04	Humor	1	3	4	44.4
15	1	0.04	Understanding	5	5	2	59.6
16	1	0.04	Respect	5	5	4	81.9
17	1	0.04	Listening	3	5	3	70.0
18	1	0.04	Observation	3	4	4	64.2
19	1	0.04	Trust	4	2	4	52.8
20	1	0.04	Sincerity	5	5	3	73.1
21	1	0.04	Equanimity	5	5	2	59.6
22	1	0.04	Objectivity	5	3	3	67.9
23	1	0.04	Discipline	5	5	2	59.6
24	1	0.04	Wisdom	3	4	3	64.5
25	1	0.04	Rectitude	5	3	2	56.5
	25	1	Average Index				65.7

#### 4. Ranking Behaviour Model

The methodology used to rank the behaviour attribute is shown in figure 10. In this model a maximum of 25 behaviour attributes were used to compute overall LBI. Assigning equal importance weight to all behaviour attributes is one method of calculating LBI. Assigning varying importance weight will give different score. Based on the organizational needs & requirements varying importance can be assigned. A systematic method of assigning varying importance weight is by conducting a survey to rank and establish the relative importance weight. A five point Likert scales comprising "strongly unimportant", "slightly unimportant", "Neutral", "slightly important" and "strongly important" were used for Lean Behaviour attributes. A score of 1 to 5 was assigned respectively to the above scale. The survey form shown in figure 11 was designed to collect the importance of lean behavior for organization's success and relevance of fat behavior for organization's failure. It was administered with lean experts to rank both Lean and Fat behaviors. Based on the survey a sum of weighted average score was calculated for all behavior attributes. The percentage weighted score for each attribute was calculated based on the total weighted score. This calculated importance weight for all behaviour attributes was assigned through input data table 6.



**Figure 10. Ranking Model - Behaviour attributes**

RANKING BEHAVIOUR													
Place the cursor over each behaviour to know the meaning													
Rank the <b>Lean</b> behaviour in terms of its importance to the Organisation's <b>success</b> in the implementation of Lean Principles													
Rank the <b>Fat</b> behaviour in terms of its relevance to the organisation's <b>failure</b> in the implementation of Lean Principles													
Based on your experience rank the behaviour by choosing the appropriate option button.													
Lean Behaviour		Strongly unimportant	Slightly unimportant	Neutral	Slightly important	Strongly important	Fat Behaviour		Strongly irrelevant	Slightly irrelevant	Neutral	Slightly relevant	Strongly relevant
S.No							S.No						
1	Self-awareness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	1	Impatience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	Humility	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	2	Talkativeness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	Compassion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	3	Favouritism	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	Balance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	4	Unclear Goals & Expectation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	Deference	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	5	Loitering	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 11. Ranking Behaviour Survey Form

5. Computation of Fuzzy Lean Behaviour Index (FLBI) & Rank

The mathworks software MATLAB & SIMULINK R2012b version was used to compute FLBI. A sample of matlab program code is given in figure 12. For a single run, maximum of 25 attributes for 15 members can be given as input. Both input & output data tables to the fuzzy model are in excel formats. The input data table is given in table 6

```

61 - for i = 1:attributes
62 -     lean_index_act(i,1) = evalfis([datasetout1.DQ1(i) datasetout1.DQ2(i) datasetout1.IQ2(i)], a)*so(i);
63 -     lean_index(i,1)=max(0,min(100,normrnd(lean_index_act(i,1),out_var)));
64 -     lean_index_tmp(i,1) = lean_index(i,1)*so(i)*w(i);
65 -     avg_lean(1) = avg_lean(1)+ lean_index(i,1);
66 -     w_avg_lean(1) = w_avg_lean(1)+ lean_index_tmp(i,1);
67 - end

```

Figure 12. Fuzzy Logic Model- Sample Program

In the input table "SO" indicates select option switch"0 or1" to include row behavior data. The value "0" indicates the behavior in the corresponding row was not included and value "1" indicates the behavior in the corresponding row was included. The input value for DQ1, DQ2 and IQ1 was entered in the corresponding cell. The behaviour importance weight obtained from the ranking model was entered in the next column. Care was taken that the sum of the weights equal to 1. The calculated FLBI scores were stored in the last column "output index". A single sheet was used for data entry of each participant. A maximum of 15 sheets were used as input for a single run of matlab program. The output in excel format consists of two sheets, one for FLBI value and the other is for FLBI rank. The scores of 25 nos. of FLBI and average FLBI scores for each participant were stored column wise. The ranks of individual and



overall behaviour attribute were stored column wise. The overall ranking for participants was stored at the last row of the table 7.

**Table 7. Lean Behaviour Ranking for Group**

S.no.	Behaviour	#101	#102	#103	#104	#105	#106	#107	#108	#109	#110	Overall
		RANK										
1	Self-awareness	6	20	23	12	24	4	11	6	25	10	15
2	Humility	18	12	13	3	16	22	7	18	21	19	18
3	Compassion	20	19	24	25	5	10	17	24	24	22	24
4	Balance	3	5	12	8	6	13	18	22	11	8	12
5	Deference	2	16	6	1	10	20	5	14	1	14	3
6	Calmness	9	3	9	4	7	16	15	13	10	15	9
7	Quietitude	13	22	25	21	25	23	24	15	18	20	25
8	Reflection	7	25	8	15	9	5	23	23	20	25	20
9	Honesty	1	2	1	7	1	6	2	9	2	1	1
10	Benevolence	14	18	3	13	12	14	8	5	9	2	6
11	Consistency	24	10	20	23	23	15	13	19	19	9	21
12	Generosity	22	13	5	22	13	18	19	10	5	18	13
13	Patience	19	15	4	2	17	12	21	4	8	21	11
14	Humor	25	8	16	20	14	3	3	20	15	24	17
15	Understanding	16	23	2	11	3	7	4	12	13	3	7
16	Respect	4	1	18	10	11	2	16	2	12	11	4
17	Listening	8	7	14	24	18	1	9	8	3	4	5
18	Observation	12	4	11	5	20	25	20	16	16	16	19
19	Trust	23	14	19	14	19	21	25	21	6	23	22
20	Sincerity	5	17	7	9	15	8	12	1	4	5	2
21	Equanimity	17	24	10	6	22	24	22	25	22	12	23
22	Objectivity	10	6	21	16	4	9	14	3	23	7	10
23	Discipline	15	9	15	19	2	17	10	17	17	13	14
24	Wisdom	11	11	17	17	8	19	1	7	7	17	8
25	Rectitude	21	21	22	18	21	11	6	11	14	6	16
	Avg rank	4	1	7	9	2	10	5	3	6	8	

For example the column under heading #101 "Honesty" is ranked first, "Deference" is ranked second. "Humor" is ranked 25. The last column gives overall behaviour rank. For example "Honesty" is ranked first, "Sincerity" is ranked second and so on "Quietitude" is ranked 25. Referring the last row of the table, member #102 is ranked first, #106 ranked low among the ten participants in the group. In a similar method the computation of Fuzzy Fat Behaviour Index (FFBI) was done.

## 6. Result Summary & Analysis

The individual FLBI score is given in the spider chart shown in figure 13 and the ranking score is given in figure 14. The higher the index score value, the better the Leanness score. The average FLBI score for an individual varied from as low as 52.2 to as high as 70.7 and average leanness score for the group is 61.7%. The average Fuzzy Fat Behaviour Index (FFBI) score for an individual varied from as low as 30.92 to as high as 43.4 and average leanness score for the group is 37.27%. The individual FFBI ranking score is shown in figure 15. For the fat behaviour index lower the value the better the score. The variation in the average Fat behaviour score is less than that of the average Lean behaviour score for the individuals.

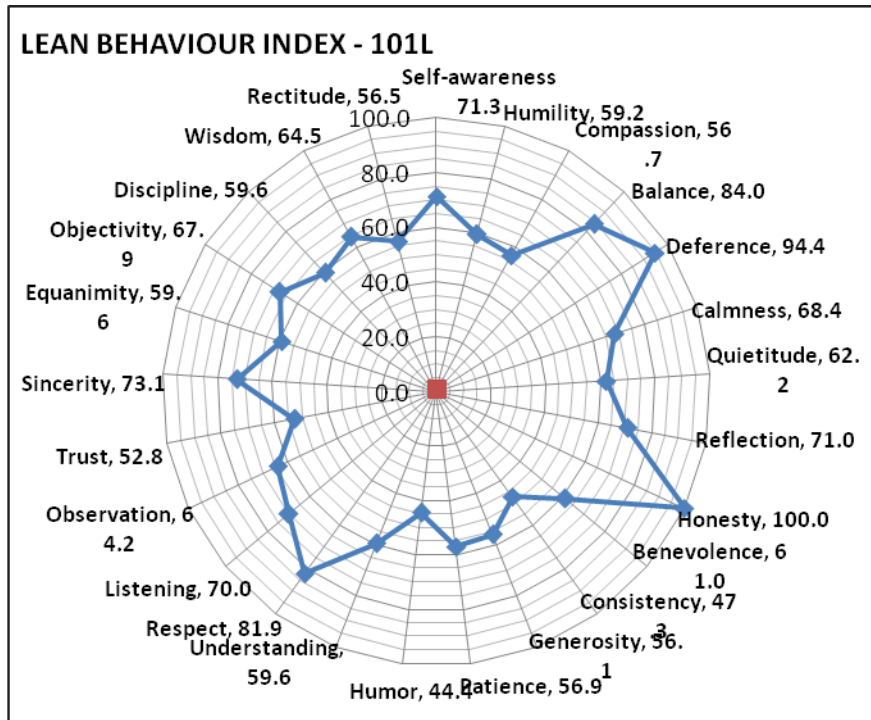


Figure 13. Lean Behaviour Index – Individual

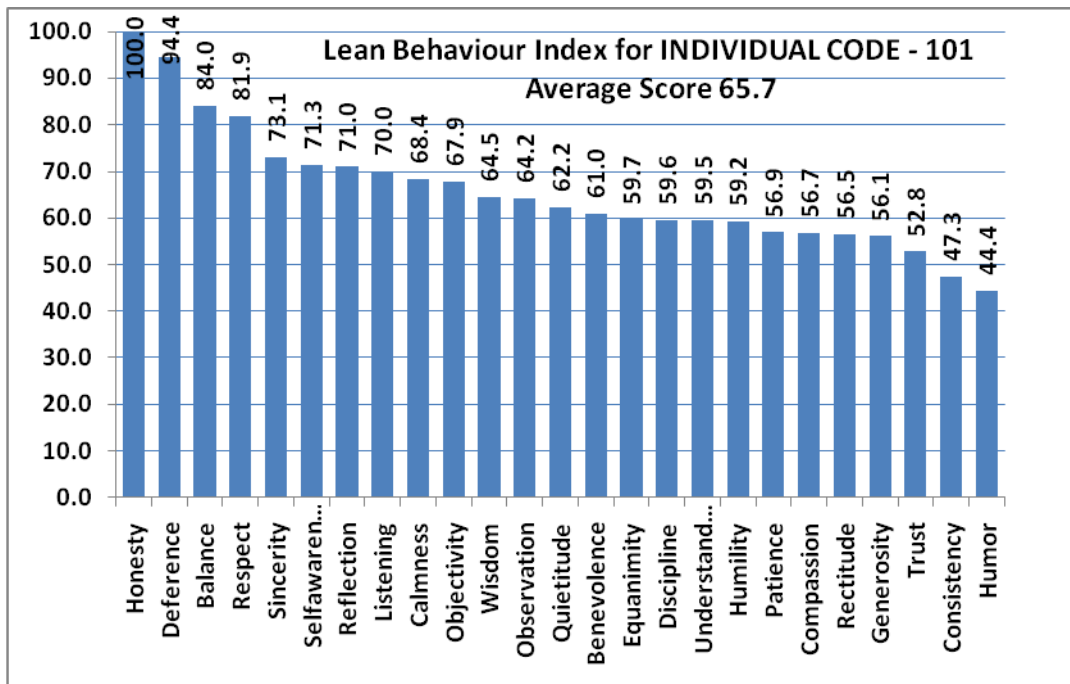


Figure 14. Ranking Lean Behaviour Index – Individual

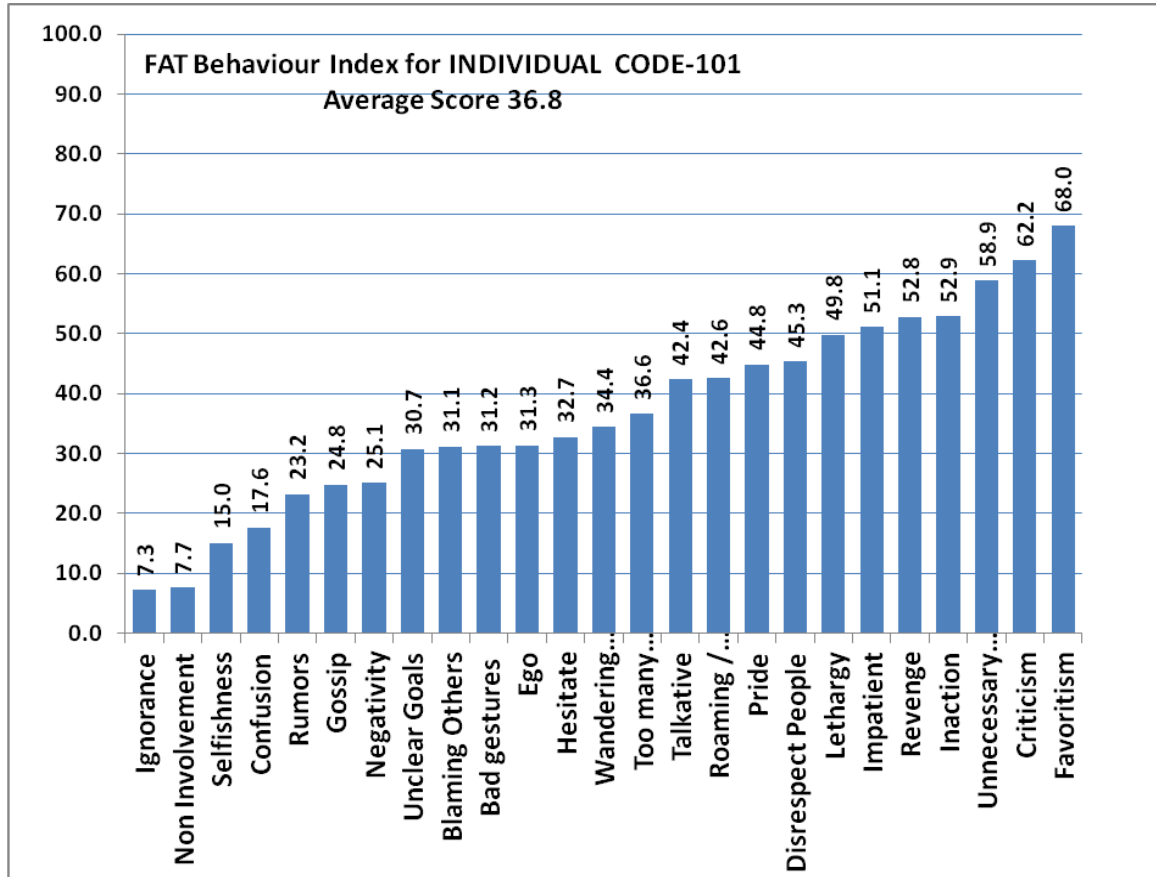


Figure 15. Ranking Fat Behaviour Index - Individual

Emiliani considered "Self awareness" is as key competency in generating Lean Behaviour and eliminating fat behaviour. However the average score is 59.6 and ranks 15 in the order. Table 8 shows the average inter behaviour score for lean attribute is 63.25 and for intra behaviour is 57.48. The reason for low score is due to poor practice of self awareness process. This triggers fat behaviours as evidenced from the figure 16.

Table 8. Average INTER / INTRA - LEAN / FAT Score for Groups

Behaviour	LEAN	FAT
INTER	63.25	36.83
INTRA	57.48	37.63



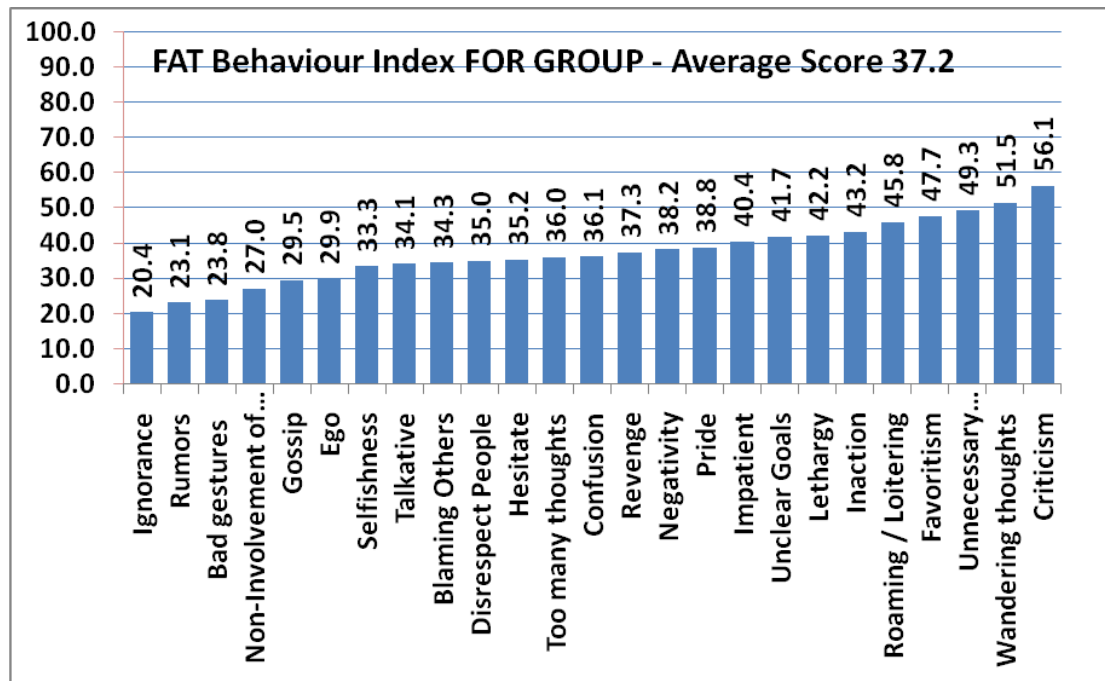


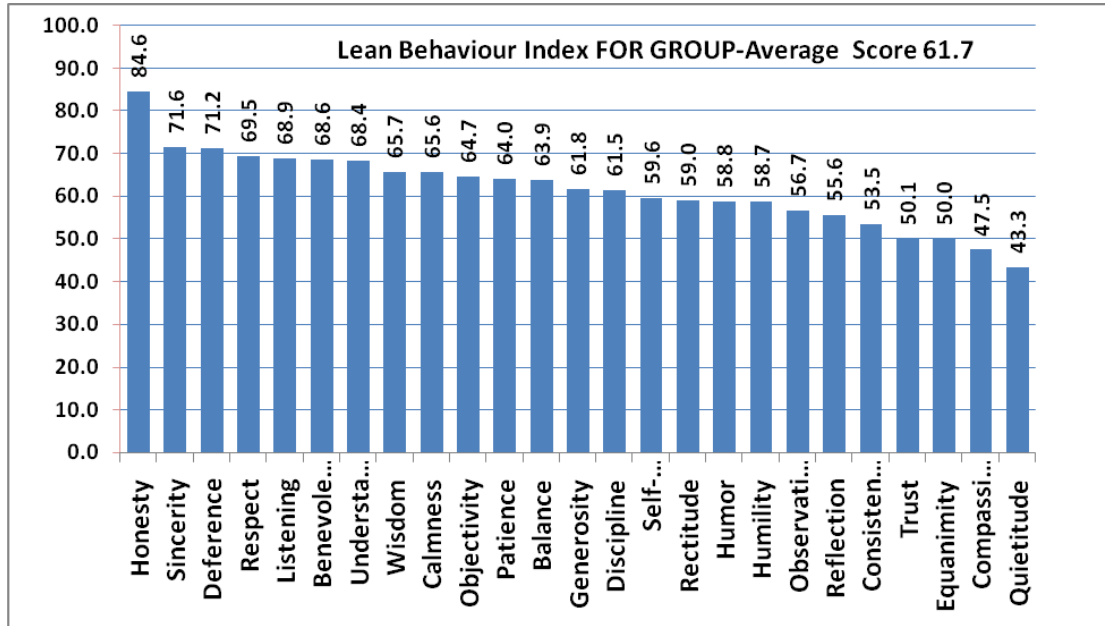
Figure 16. Ranking Fat Behaviour Index - Group

Another key competency is building mutual trust between people. The presence of low TRUST between employees as evidenced from figure 17 prevents free and fair flow of communication among them and thus generating fat behaviours like "Inaction or delays in action", "Unclear Goals", "Favouritism", "Criticism", "Lethargy" and "Consistency". This is evidenced from the figure 16.

All the lean attributes (25 nos.) can be grouped into simple three groups namely 1) "MUST have behaviours" - minimum essential behaviour required in the organisation, 2) "SHOULD have behaviours" - behaviours that improve organisation's performance and promote lean and 3) "DELIGHTFUL behaviours" - Behaviours that sustains Lean transformation. The table 9 shows average score level for the above three groups. It may be seen from the figure 17 the second and third group Lean behaviour attributes requires improvement. The people in the organisation should practice Lean behaviours such as Self awareness, Discipline, Reflection, Consistency, Trust, Equanimity and Compassion towards improvement of scores for all the three groups.

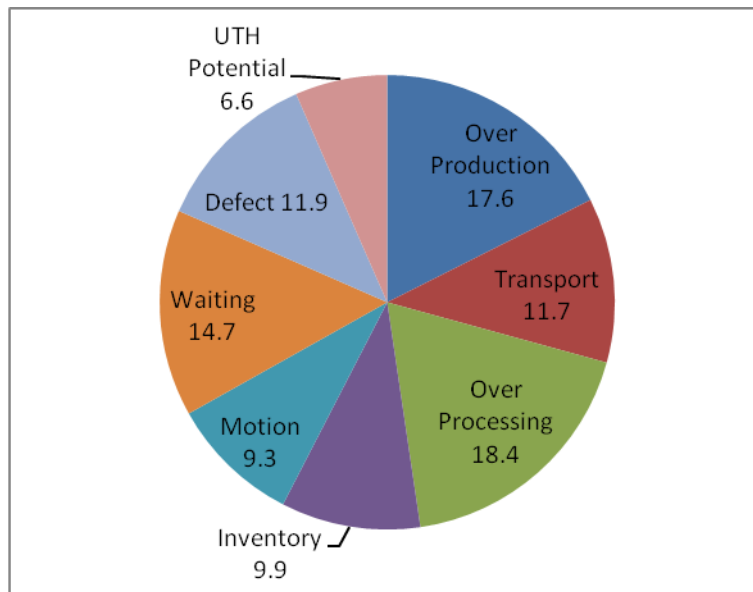
Table 9. Average LEAN Score for Groups

LEAN Behaviours	Average Score
MUST have	67.90
SHOULD have	62.31
NICE to have (DELIGHTFUL)	54.85

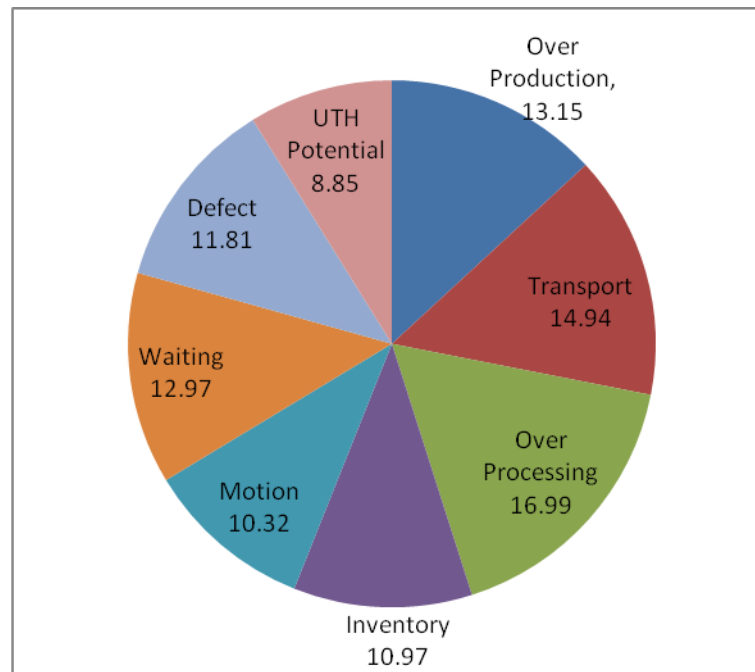


**Figure 17. Ranking Lean Behaviour Index – Group**

The classification of Fat behaviours in terms of eight types of waste provides valuable information about what type of waste that may occur from both manufacturing and behavioural context. The figure 18 shows classification of Fat behaviour score for an individual and figure 19 shows for the group. In the group classification Over processing type of behaviour waste contributes the highest score followed by Transport, Overproduction, Waiting, Defect, Inventory and Motion.



**Figure 18. Classification of Fat Behaviour Index- Individual**



**Figure 19. Classification of Fat Behaviour Index - Group**

For an individual behaviour attribute, the score varied from a low value of 7.5 to a high value of 100%. Based on the above information the individual and the organisation could focus on low score behaviour for improvement. The bench mark value could be fixed for all behaviours based on the survey from the experts. Gap analysis could be done for further improvement.

## 7. Conclusion

The outcome from this research could be useful for individuals by awareness of their behaviour. It gives motivation to improve the low score and monitor the progress of improvement so that they could add more value to their organisation. The organization could use this score to recruit new employees, develop & promote employee based on their scores. The employer can input behaviour importance weight based on their organisation's requirements and rank them. Unlike other tools available for attitude measurement which gives score in the macro level, this fuzzy model gives score in the micro level and this methodology can be adopted for any other behaviour attribute measurements not included in the model. This methodology can be used for an unbiased evaluation of Leanness Behaviour. It also facilitates decision making process in the absence of complete and precise information. This model shall be extended to evaluate employee Lean Competency Index (LCI) in terms of Lean knowledge, skill & attitude. A study on the application of Lean Principles towards generation of Lean Behaviour and elimination of Fat Behaviour shall be carried out in order to assess the impact of improvement that will benefit Lean organisation.

## 8. References

1. Ching-Torng Lin, Hero Chiu, Yi-Hong T seng (2006) "Agility evaluation using fuzzy logic", International Journal of production economics, 101,353-368.
2. Cleary T., (1989), "Zen Lessons – The Art of Leadership", Shambhala, Boston, MA.
3. Cleary T., (1996), "The Human Element", Shambhala, Boston, MA
4. Emiliani M.L. (1998) "Lean Behaviors" – Management Decision, Vol 36 Issue 9 PP 615-631.
5. Emiliani M.L. (1998) "Continuous Personal Improvement" Journal of Work Place Learning, Vol 10, No 1, PP 29 – 38.
6. Emiliani M.L.(2003) "Linking Leaders' Beliefs to Their Behaviors and Competencies", Management Decision, Vol. 41, No. 9, pp. 893-910.
7. Eswaramoorthi M., Kathiresan G.R., Syath Abuthakeer S., Mohanram P.V., (2009)," Research Issues in Lean Manufacturing" Proceedings of Sixth International conference on Precision,Meso,Micro and Nano Engineering, Vol 1, pp 47-53.
8. Eswaramoorthi M., Kathiresan G.R., Prasad PSS., Mohanram P.V., (2011), " A survey on lean practices in Indian machine tool industries" International journal of advanced manufacturing technology, 52(9-12), 1091-1101.
9. Gliem JA, Gliem RR, (2003), "Calculation, interpreting and reporting Cronbach's alpha reliability coefficient for Likert-type scales", Midwest Research to Practice Conference in Adult, Continuing & Community Education, Columbus, OH, pp. 82–88.
10. GOLDBERG, L. R. (1992) The development of markers for the Big Five factor structure. *Psychological Assessment*, 4, 26-42.
11. James P. Womack, Daniel T. Jones, Daniel Roos, (1990), " The Machine That Changed The World", Simon & Shuster Ltd.
12. Jeffrey K.Liker, (2004) "The Toyota way -14 Management Principles", Mc Graw Hill Education.
13. Mohanram P.V., Kathiresan G.R., (2012) "Self-awareness - Key to Lean Behaviour", Proceedings of National convention of mechanical Engineers conducted by PSG College of technology and The Institution of Engineers india.
14. Myers, Isabel Briggs, Mary H. McCaulley, Naomi Quenk, and Allan Hammer. (1998) *MBTI Handbook: A Guide to the development and use of the Myers-Briggs Type Indicator* Consulting Psychologists Press.
15. Ramchander P, (2004), Research design and Methodology, University of Pretoria, pp. 104–129.
16. Udai Pareek, 2002, "Training Instruments in HRD and OD", Tata McGraw-Hill.
17. Vinodh S. Suresh Kumar Chintha (2010) "Leanness assessment using multi-grade fuzzy approach" International Journal of Production Research, 49:2,431-435.