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Leanassessmentusingfuzzyinterferencedecisivesysteminmanufacturing Industries

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ABSTRACT
Lean Strategies Have Been Developed To Eliminate Or Reduce Manufacturing Waste And Improve Operational Efficiency In Manufacturing Processes. Nowadays, Industries Aim To Improve Their Productivity Without Compromising Quality Of Product. In Order To Achieve That, Industries Implement Management Philosophies Like Lean Manufacturing, Agile Manufacturing And Total Quality Management Etc. Lean Is An Effective, Tested Method Of Reducing Operating Costs And Removing Waste From Manufacturing Operations. In A Manufacturing Context Products And Production Processes Are Visible And Waste Is Easy To Identify. Implementing Lean Production At Initial Stages Is More Complex But At Later Stage The Results Will Be Appreciated. In Lean Transformation Process, It's Also Critical To Measure The Current And Desired Leanness Levels In Order To Clearly Evaluate Lean Implementation Efforts. Despite The Fact That Many Lean Strategies Are Utilized To Reduce Or Eliminate Manufacturing Waste, Little Effort Has Been Directed Towards Properly Assessing Leanness Of Manufacturing Organizations. In Practice, A Single Or Specific Group Of Metrics (Either Qualitative Or Quantitative) Will Only Partially Measure The Overall Leanness. Existing Leanness Assessment Methodologies Do Not Offer A Comprehensive Evaluation Method, Integrating Both Quantitative And Qualitative Lean Measures Into A Single Quantitative Value For Measuring The Overall Leanness Of An Organization.
Keywords: Lean Production, Toyota Lean System, Lean Tools, Waste Elimination, Fuzzy Logic.

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I. INTRODUCTION

Lean Principles Are Defined For The Growth And Survival Of The Industries Related Into Production And Also To The Service Sector. As Needs Are Increasing, Expectation Of Quality Work Is Also Increasing. However, Implementing Lean Strategies Requires A Large Amount Of Resources And, In Practice, Manufacturers Encounter Difficulties In Selecting Appropriate Lean Strategies Within Their Resource Constraints. Lean Helps To Identify Non Value Added Services And Removes Waste From The Process. A Continuous Use Of The Proposed Technology Helps To Grow The Industry In Terms Of Customer Satisfaction And Finance. Lean Manufacturing/Production Has Been A Term That Has Been In Widespread Usage Since The Early 1990's When Womack And Jones First Used It To Describe The Toyota Production System. Similar To Its Predecessors Of Craft/Job Shop Production, Mass Production And Batch Production, Lean Production Is A Generic Term That Is Used To Imply A Particular Way Of Going About The Manufacture Of A Particular Product. Henry Ford's Insight Of Lowering The Expense Associated With Making A Product By Shorting The Production Cycle Times Is Similar To That Of Lean Production. A Lean Production Manager Is Challenged To Find New Ways To Increase The Productivity And Efficiency Of Their Business.

Because Manufacturing Environments Vary Due To Differences In Their Purpose, Design And Control, There Is No Single Set Of Management Procedures That Can Be Universally Adopted To Govern Them[15] However, Lean Production Provides Us With A Starting Point For Viewing A Company's Operating Practices With The Final Goal Of Seeking Operational Improvement. Manufacturing Managers Are Responsible For Demonstrating A Sound Understanding Of Their Manufacturing Systems, In Order To Create Work Environments That Are Creative, Competitive, And

Continuously Improving[22]. It Therefore Means That Operations Managers Hoping To Join To Workforce Will Have To Be Able To Replace Their Ageing Counterparts And Also Continue The Lean Revolution. The College Of Technology, At Purdue University,

Has Developed An Introductory Course To Lean Production/Manufacturing For Freshmen And Sophomore Students In Hopes That A Better Educated Workforce Will Be Present To Undertake The Continuation Of The Lean Revolution.

Lean Manufacturing Is Defined As "A Philosophy, Based On Toyota Production System, And Other Japanese Management Practices That Strives To Shorten The Time Line Between The Customer Order And The Shipment Of The Final Product, By Consistent Elimination Of Waste". All Types Of Companies, Manufacturing, Process, Distribution, Software Development Or Financial Services Can Benefit From Adopting Lean Philosophy. As Long As A Company Can Identify A Value Stream, From When The Customer's Order Product To When They Receive It, Lean Principles Can Be Applied And Waste Removed. Also, Lean Manufacturing Is: "Adding Value By Eliminating Waste, Being Responsive To Change, Focusing On Quality, And Enhancing The Effectiveness Of Work Force". Another Definition For Lean Manufacturing: "It Is A Systematic Approach To Identify And Eliminate Waste (Non-Value Added Activities) Through Continuous Improvement By Following The Product At The Pull Of The Customer In Pursuit Of Perfection" .The Lean Manufacturing Paradigm, Discussed In An Extensive Manner In The Literature, Is Considered Applicable To The Majority Of The Industrial And Service Processes, Bringing Benefits Like Productivity Improvement, More Aggregate Value In The Products, Waste Reduction And Higher Level Of Customer's Satisfaction.

The Term "Lean" Was Introduced Womack [21] To Describe A "Better Way Of Organizing And Managing Our Relationships With Clients, Supply Chain, Product Development And Production Operations", Based On The Toyota Production System (Tps). The Lean Principles Can Be Briefly Stated As Value – Enhancing Value To The Customer, Value Stream – Identifying Where The Value Is Created And Removing The Waste Where It Is Not Present, Stream – Making The Product To Flow In Line, Without Interruptions, Pull – Producing Only What The Customer Or Next Process Solicits, And Perfection – To Pursue The Perfection, Removing More Waste Continuously.

II. LITERATURE SURVEY

Lean Manufacturing Is Regarded As A Manufacturing Philosophy That, If Adopted And Carefully Implemented, Can Form The Roadmap To Global Manufacturing Excellence [23]. Lean Manufacturing Is Designed To Eliminate Waste In Every Area Of Production Extended To Customer Relations, Product Design, Supplier Networks And Factory Management. Its Target Is To Incorporate Less; Human Effort, Inventory, Time To Develop Products And Space, To Become Highly Responsive To Customer Demand While Producing Top Quality Products In The Most Efficient And Economic Manner Possible. Moreover, Lean Manufacturing Emphasizes The Minimization Of The Amount Of All Resources (Including Time) Used In The Various Activities In The Enterprise.

Lean Manufacturing Has Evolved As An Alternative To Mass Production, Which Relied On Long Runs Of Limited Varieties Of Products For A Steadily Expanding Marketplace Of Homogeneous Tastes, As Referred To In This Section. Thus, For Businesses To Qualify And Continue Surviving In Such Precarious Market Conditions, They Ought To Devise Means Of Eradicating Non-Value-Added Wastes That Drive The Overall Cost Of Their Operations. The Application Of Lean Manufacturing Within Business Functions Has Diverse Impacts, Such As The Improvement Of Working Procedures And The Realignment Of Organizational Practices[23].In Lean Manufacturing, Waste Is Identified As Anything That Does Not Add Value To The Process Or Service Delivered To The Customer. In The Lean

Manufacturing Process, A Large Number Of Tools And Techniques Have Been Used To Address Different Kinds Of Wastes In Manufacturing Organizations.

Every Tool Or Technique Was Developed To Solve A Problem And Eliminate The Waste Found In The

Production Line. Lean Manufacturing Therefore Is A Very Significant Productivity Improvement Technique Whose Benefits Can Be Described As The Reduction Of Wastes In An Organization [19]. Thus, It Helps A Manufacturing System To Become Leaner In Some Aspects. However, It Is Often Difficult To Select A Proper Tool From The List Of Large Number Of Lean Tools To Address Particular Types Of Wastes.

The Process Of Transforming Raw Material Into Finished Goods Is The Objective Of Any Manufacturing Company,[23] The Processes That Make That Transformation Possible Are The Result Of Three Different Activities:

- Value Adding Activities
- Necessary But Non-Value Adding Activities
- Unnecessary Non-Value Adding Activities

Value-Added Activities (Va): Womack[21] Stated That Va Activity 'Directly Results In The Accrual Of Value In The Eyes Of The End Customer So That This Kind Of Activity Is

Considered Essential With Regard To The Perceived Quality Of Final Offering And Regulatory Compliance. It Is That Activity Which Is Unthinkable Not To Conduct In Any Future State Model Or Scenario'[21].

Non-Value-Added Activities (Nva): Nva Is 'Any Activity Which Adds Cost But Creates No Value So That Can Be Removed Immediately' [17]. Nva Is A Kind Of Pure Waste Which Needs To Be Eliminated Immediately. It Is Notable That These Kinds Of Activities Need To Be Reduced Or Eliminated With 'Minimum Or No Capital Investment And With No Detrimental Impact On End Value' In A Short Run.

Necessary But Non-Value-Added Activities (Nnva):Nnva Is The Activity Which Creates No Value But Is Still Necessary Because Of The Current Limitation Of Technology, Capital Assets And
'Operating Procedures Of The System Under Examination'[21], Which Is Also Called Type One Muda

(Waste) As Classified By Womack & Jones. The Document Movements Between Company
Departments Are A Typical Example Of Nnva. According To Womack & Jones[21], 'This Kind Of Activity Will Ideally Be Eliminated In The Long-Run But It Is Envisaged That This Will Require Capital Investment And/Or Reengineering Activity'.

Lean Manufacturing (Lm) Is The Set Of Practices Intended To Attain Perfection In The Identification And Elimination Of Waste Through Continuous Improvement Flowing The Product At The Pull Of The Customer [1]. These Practices Are Encompassed In A Broad Range Of Tools And Techniques: Just-In- Time, Total Quality Management, Total Productive Maintenance, Kaizen, Kanban, Poka Yoke, Statistical Process Control And Many Others. Lm Is A Philosophy And So The Practices Are Not Concrete Objects [2], But There Are Metrics Or Key Performance Indicators (Kpis) That Are Used In Tracking The Success Of Lean Initiatives. Each Kpi Assesses Performance For One Or More Practices, And To Assess Overall System Lean Performance, The Lean Index (Li) Is Introduced As A Metric [3].With The Lean Index (Li), The Many Lm Kpis Of A System Can Be Compressed Into One Composite Indicator. In The Extant Literature On Li Models, Qualitative [4-6] And Quantitative Li [7-11] Models Have Been Established. The Qualitative Types Rely On Self-Rated Assessments And Are Susceptible To Bias. The Quantitative Types, On The Other Hand, Are More Objective As They Use Data That Are Tracked Directly With Numbers. An Attempt To Incorporate Both Quantitative And Qualitative Li Modelling Into A Single Lean Assessment Framework Was Made By Pakdil AndLeonard [11]. In Their Work A Fuzzy Logic (Fl) Based Li Was Introduced For The Qualitative Aspects Of Lm.

Operational Tools Of Lean Manufacturing

There Are Many Lean Tools And Techniques Which Help Manufacturing Organizations To Implement Best Manufacturing Practices [14]. Organizations Should Therefore Choose The Most Appropriate Lean Techniques/Methods That Are Ideal To Individual Manufacturing Needs. Successful Implementation Of Lean Strategies Requires Functional Understanding Of The Key Operational Tools Of Lean Manufacturing. The Lean Tools Used In This Thesis Are Adopted From Other Research [14]. They Are: Total Quality Management (Tqm), Single Minute Exchange Of Die (Smed), Total Productive Management (Tpm), Production Smoothing, Just-In-Time (Jit), 5s, Kanban, Standard Work, Visual Control, And Cellular Manufacturing, Safety Improvement Program, Information Management System And Method-Time Measurement (Mtm). Below Is A Summary Of Some Of The Notable Lean Strategies.
F
1.5s Method

5s Is A Lean Manufacturing Practice That Helps Organizations To Sort, Set In Order, Shine,

Standardize, And Sustain Productive Work Environment. It Helps To Improve The Following Areas In A Manufacturing Organization.

- Long Lead Times
- Low Productivity
- High Operating Costs
- Late Deliveries
- Unreasonable Ergonomic
- Space Constraints
- Frequent Equipment Breakdowns
- Hidden Safety Hazards

The 5s System Includes Five Steps Described Below
Sort: To Tidy The Organization. It Refers To Going Through All Tools, Materials And Equipment In The Plant And Work Area, Retaining Only Necessary Items. Other Objects Are Thrown Out, Which Leads To Less Adverse Impacts To The Production Work.
Set In Order: To Ensure Organization Orderliness. Each Item Should Be Clearly Labelled And Systematically Arranged For The Easiest And Most Efficient Access In Order To Promote Efficient Work Flow. It Focuses On Organizing The Work Area By Making It Such That Everything Has A Place And Everything Is In Its

Place. The Requirements For Arranging In Order Should Include: Storage Should Be Simply Organized With Visual Confirmation; Most Frequently Used Tools And Equipment Are Located Closely To The Employee; The Tools, Toolboxes And Drawers Need To Be Arranged Visibly To Open And Close With Less Motion; Work Instructions Are Updated Regularly And Presented At The Workstation; Ergonomic Guidelines Should Be Used In Work And Tool Design; Key Indicators Should Be Shown An Information Boards To Give Guidelines For Workers, Product Lines As Well As Production Goals And Status Such As Inventory, Training, And Calibration.

Shine: 'Shine' Brings A Workspace Back To Proper Order By The End Of Each Working Day. It Requires Periodic Systematic Cleaning. There Are Responsible Operators Establishing The Cleanup Methods (Such As Tools, Checklists). They Inspect The Results Periodically To Keep The Workplace Clean And Neat. At The End Of Each Shift, The Work Area Should Be Cleaned And Everything Is Restored To Its Place. This Makes It Easy To Know What Goes Where, Ensuring That Everything Is

Where It Belongs And Is Ready To Use At Any Time. What's More, It Is Important To Make This Daily
Task Become A Habit.

Standardize: Standardize Is Used To Maintain The First Three S's And Turns Those Duties Into Regular
Work Routines. These Methods Should Be Standardized And Followed By All The Staff Company- Wide. Once The First Three S's Are Established, The Work Details Are Formulated Into Regulation And Maintained Every Day. This Regulation Should Consist Of Procedures And Simple Daily Checklists, And Should Be Posted In Every Work Station.

Sustain: Once The Previous Four S's Have Been Established, They Become The New Routine And Part Of The Company Culture. So The Fifth 'S', Sustain, Makes The Organization Sustain The Previous Four S's And Does Not Allow The Companies To Fall Back Into The Old Ways.

Following The 5s Principles Allows Organizations To Reduce The Time Wasted In Searching For Lost Items In The Manufacturing Facility, While Cleaning The Manufacturing Facility Regularly And
Keeping Items In An Orderly Fashion Assures Enhanced Safety For Workers And Benefits Machine
Reliability, Among Other Factors.

2. **Kanban**

This Is A Japanese Word Which Means 'Card' Or 'Visible'. It Was First Developed By Taiichi Onho To Control Production Between Processes And Implement Jit Manufacturing At Toyota

Manufacturing Plants In Japan. Kanban Is A Signaling Card Which Has Information About Amounts Of Product To Be Produced, Origin Of The Product, And Destination Of The Product. The Kanban
Methodology Is Designed To Simplify Material Handling And Inventory Management. Instead Of

Stacking The Materials Issued To The Production Near The Line In Larger Quantities, Smaller Quantities Of Materials Are Physically Present At Point Of Usage On The Line And Replenished Only When A Kanban Or Signal Is Generated [23].

• Only Produce Products Based On A Signal Sent By The Customer

By Implementing Kanban, Toyota Manufacturing Was Able To Reduce Wip And The Cost
Associated With Holding Inventories.Other Benefits Of Kanban Include [23]:

• Reduced Inventory
• Improved Flow
• Reduced Or Eliminated Overproduction
• Improved Responsiveness To Change In Demand
• Increased Ability To Manage The Supply Chain

Fuzzy Logic Based Assessment For Lean Manufacturing Principles

[13] Developed A Systematic Measurement Algorithm For Lean Assessment Of Manufacturing Systems. They Used The Fuzzy-Logic Methodology Since They Believed Lean Is A Matter Of Degree. They Compared The Production Leanness Of Ford Motor Company And General Motors Company Selecting Honda Motor Company As A Benchmarking Firm. They Proved That The Ford Motor System Is 17% Leaner Than The General Motors System Through The Benchmarked System. Following This, They Chose Jit, Kaizen, And Quality Control As Lean Attributes. However, They Only Attempted Quantitative Performance Metrics.

It Has Been Presented A Model To Assess Leanness Of The Organization Using The Multi-Grade Fuzzy Approach. The Disadvantage Of This Method Is That Advanced Methods Of Fuzzy Logic Have Not Been Explored And Proposed A Model To Assess Level Of Agility Using Fuzzy Logic. This Model Lacks

The Usage Of Advanced Membership Functions Of Fuzzy Logic For Integrating Both Qualitative And Quantitative Performance Metrics To Generate A Single Leanness Value.

Fuzzy Importance

One Of The Widest Spread Assertions About Production Is Ending Period Of Mass Production Era And Substitution Of Novel Forms Like Flexible Allocation Instead. Waste Management Or Lean Production Is A New Phase Of Production, Take Mass And Craft Production Benefits Altogether. This Method Is Based On Multi-Skill Workers As Well As Automatic And Flexible Machines. In This Method We Try To Reduce Production Space, Investment On Tools, Engineering Work Time, And Stagnant Inventory To Half And Make Our Attention To Zero Defects And Zero Inventory. In The Lean Production Method, Producers Desire In Reducing Resource Consumption. In This Method, Work Force, Capital Invested In Machinery Purchasing And Installation, Space Required For Production, In Progress Products, Materials, And Products' Inventories And Engineering And Design Personnel Are Reduced To Half. Therefore, Designing And Building Period As Well As Distribution And Selling Of A Product Would Be Halved, And This Is Just The Main Goal Of Lean Production [17]. After Lean Production Introduction In 1970s, Many Books And Articles Have Been Published Regarding Various Aspects Of Leanness Which Show The Effect Of This Paradigm On The World Of Production And Operations. Orienting Management Research Toward Lean Concepts, Lot Of Attempts Devoted To Development Of A Tool To Measure Organizational Leanness, Since In Order To Have Any Kind Of Analysis, Planning And Then Control (That From Main Elements Of Management), Having A Well- Founded And Structured Style For Evaluation Of Concepts Is Inevitable. In This Regard, Various Styles Are Proposed By Researchers For Measuring Organizational Leanness, Like Methods According To Logical Concept Of Hierarchal Process Which Are Developed For Organizations' Comparison From View Point Of Leanness. In This Process, Pairwise Comparisons Are Used To Assess Organizations' Leanness Capability. However, Most Researches Use Integrated Index For Measuring Organizational Leanness, That Is Sum Of Simple Or Weighted Items' Scores.

Cited Methods Are Simple And Comprehensible, But Since Occasionally Some Of The Lean Indexes Are Ambiguous And Have Unclear Definition, And In Some Cases There Is No Enough Evidence For Assessment, Or Even Experts Do Not Have Enough Ability To Assess The Indexes Meaningfully, Ambiguity And Vagueness Is Hidden In The Essence Of Lean Assessment Methods. Therefore, Using Indexes To Score Lean Capabilities Has Two Limitations:

1. These Techniques Do Not Take In To Account Ambiguity And Multiple Probabilities Related To The

One Person`S Perception And Judgment About A Number.

2. Estimator`S Choice, Preferences And Subjective Judgments Have Prominent Effect On These Methods.

Therefore, Using Fuzzy Logic And Linguistic Variables, May Render A More Exact Assessment About The Degree Of Organizations' Leanness. Many Of Lean Scales, When Encounter With Ambiguities And Multiple Probabilities, Are Explained Subjectively By Linguistic Variables. By Using Fuzzy Concepts, Estimators Can Use Linguistic Variables As Common Lexical Words And In Order To Assess The Indexes And Then Link Each Linguistic Variables To A Fuzzy Membership Function. Since Fuzzy Logic Do Not Impose Any Assumptions About Independence, Integrity, Or Monopoly Of Evidences, It Makes It Possible To Use Ambiguous Boundaries In The Definitions And Moreover It Make Possible To Use Qualitative Data In Measuring And Assessment Studies Appropriately Using This Approach, In This Paper A Model Based On Fuzzy Logic Has Been Developed, To Prepare A Proper Tool For Measuring An Organization's Leanness. In This Approach, Performance And Preference Weights Of Various Lean Capabilities Have Been Evaluated And Expressed As Linguistic Variables By The Experts.

Then, Appropriate Fuzzy Numbers For Expression Of Linguistic Variables Are Defined And By Performing Fuzzy Calculation Operations, "Fuzzy Leanness Index" (Fli) Is Attained. Finally, Fli Is Matched To A Proper Linguistic Variable And Therefore Lean Level Is Expressed As Linguistic Variables.

Fuzzy Overview

The Criteria For Measuring Subjects And Phenomena Are Different Base On Organizational Behavior And Research Requirements. Nevertheless, What That Would Be Fix Forever, Is The Process And Method Of Measuring. In This Process, Person Or Persons Who Enjoy Enough Expertise On The Research Question Domain Would Change Qualitative Data To Differentiable Values. However, Care Must Be Applied That Such A Methods, Neglect Ambiguity Related To Individual's Judgment And Their Value Changes During Transformation To Numbers. Fuzzy Logic Was First Introduced By Professor Zadeh In 1965, In Order To Answer Such A Challenge. He Believes That Human's Logic Can Take Advantage Of Concepts And

Knowledge That Do Not Have Well-Defined Borders [24]. Fuzzy Logic Comprise A Wide Spectrum Of Theories And Techniques Mainly Constructed Upon Four Concepts: Fuzzy Sets, Linguistic Variables, Probability Distribution (Membership Function), And Fuzzy If-Then Rules[24]. Fuzzy Sets And Linguistic Variables Are Widely Used As The Two Fundamental Concepts In Qualitative Assessments. Fuzzy Set Is A Set In Which Members' Certainty Of Membership Is Rejected And Every Member Belongs To The Set With Its Own Specific Membership Degrees.

Fuzzy Logic Is A Mathematical Logic That Deals With Reasoning That Is Approximate Rather Than Fixed And Exact. Fuzzy Logic Systems Are Capable Of Solving Imprecise Problems Efficiently. It Includes Fuzzy Rules Which Describe The Nodes Mobility In An Adaptable Way With The Traffic Environment. In Fuzzy Logic System, We Assign Multiple Values To A Wide Spectrum Of Vague Data As An Input In Order To Attain The Most Accurate Conclusion Possible. There Are Basically Three Steps Involved In Order To Implement Fuzzy Logic Technique To A Real Life Application. These Are

1. Fuzzification
2. Fuzzy Inference System (Fis), And
3. Defuzzification.

Fuzzification Is The Process Of Converting The Classical Data Also Known As Crisp Data Into A

Linguistic Variable Using The Membership Functions (Mfs) Stored In The Fuzzy Knowledge Base. A Numerical Variable Takes Some Numerical Values E.G. Speed Is 50 Km/Hr, Whereas A Linguistic Variable Takes Linguistic Values E.G. Speed Is Very High. These Linguistic Values Constitute A Fuzzy Set. Thus, Linguistic Variables Are Those Variables That Can Take Words As Its Values In Natural Languages.

Fuzzy Inference System Maps Inputs By Combining A Set Of Membership Functions With The

Control Rules To Fuzzy Outputs. It Provides Natural Thinking Mechanism Based On Human Knowledge That Include Imprecision And Ambiguity As Shown In Figure 2. Fuzzy Knowledge Base Stores If-Then Rules Provided By Experts.

Defuzzification Is The Process Of Converting The Fuzzy Output Of The Fis To Crisp Value Using Mfs.

Different Methods Like Centroid Of Area (Coa) Or Mean Of Maximum (Mom), Fuzzy Mean (Fm) Etc. Can Be Used To Get A Quantifiable Result.

The Major Motivation Of The Fuzzy Logic System Is To Accomplish Considerable Improvement In
The Performance Of The Original Routing Protocol Through The Improvement In The Procedure Of Selecting The Next Hop Forwarding Node For Further Transmission.

III. METHODOLOGY

The Main Goal Of The Paper Is To Render A Method Compatible To Inexact Human Assessments For
Measuring Organizations' Leanness. This Method Stages Are As Follows:

1- Defining Lean Attributes: Defining The Lean Attributes (Enablers) Is The First Step In This
Algorithm. In This Stage A Proper Set Of Lean Scales With High Validity And Reliability Would Be Defined By A Deep Study Of Literature And Investigation Of Organizational Lean Assessment Methods In The Researchers' Surveys.

2- Defining Proper Linguistic Variables: As Mentioned, Ambiguity Existed In Human Assessment About Items, Make Using Crisp Methods Unreliable. Fuzzy Logic Considering Ambiguity And Uncertainty, Maintain An Appropriate Tool For Encountering With Ambiguity In Human Assessments. Linguistic Variables And Relevant Membership Functions Have Been Extensively Used By Researchers In Operations Management. A Variety Of Famous Linguistic Variables And Related Membership Functions Are Proposed For Linguistic Assessments. For Convenience, We May Directly Use Past Studies Or Modify Them According To The Research Needs And Respondent Conditions, In Order To Define Appropriate Linguistic Variables And Their Related.

IV. DATA COLLECTION

The Research Work Set Out In This Paper Adopted Qualitative Research Technique In Its
Investigation. This Includes Company Visits And Discussing With The Key Resource People To Understand The Process. After Analysis, The Data Is Collected And Formatted As Needed For Our Research. We Made Analysis Using Ms-Excel And Matlab Tools. The Various Visited Industries.

S.NO.	COMPANY NAME	COMPANY ORIGIN STATUS	COMPANY PROFILE
1	*ASB Technologies*	MNC(Japan)	Manufacturing of bottle molding machines
2	*PAR FILTER Pvt Ltd.*	Indian	Manufacturing of Filter masks for pharmaceuticals
3	*ASHTAVINAYAK Pvt. Ltd*	Indian	Electrical component manufacturing and assembling
4	*VAISHNAVI Pvt.Ltd*	Indian	Customised gear component manufacturing
5	*TECHEPROSOFT Solutions*	Indian	PCB manufacturing and software based automation production

Table 1. Company Visits

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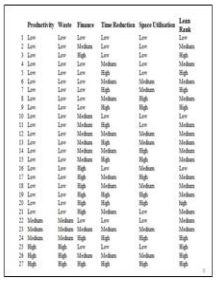

Table 1.Fuzzy Rules Used In our Study

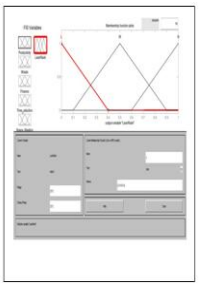

Fig.1.Lean Fuzzy Input and Output

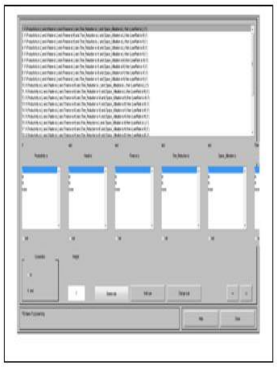

Fig.2.Lean Fuzzy Rules

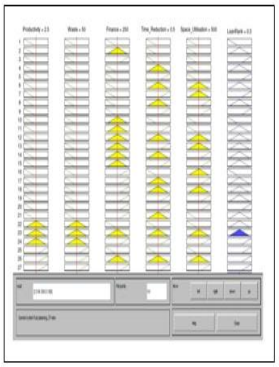

Fig.3.Lean Fuzzy Rank

V. CONCLUSION

Even Though Lean Production Has Glided By Its Inception Stage In Recent Years, Yet There Are Few Steps To Achieve Its Maturity. Actually It's Still Not Clear As To What Extent Should Be Lean, What Should Be The Indicator To Measure Leanness. How Organization Should Measure Leanness. Addressing These Issues Is Essential For The Theory Of Lean Development As Well As Lean Experts. Goal Of This Research Tends To Address These Issues By Focusing On Measuring Leanness. A Complete Algorithm Was Developed To Measure The Leanness Of An Organization. The Results Obtained Reflect The Effectiveness And Accuracy Of The Proposed Method.

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