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Identification of Lean Implementation Hurdles in Indian Industries

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Abstract**—**Due to increased pressure from global competitors, manufacturing organizations are switching over to lean philosophies from traditional mass production. Lean manufacturing is a manufacturing philosophy which focuses on elimination of various types of wastes and creates maximum value for the end customers. Lean thinking aims to produce high quality products and services at the lowest possible cost with maximum customer responsiveness. Indian Industry is facing lot of problems in this transformation from traditional mass production to lean production. Through this paper an attempt has been made to identify various lean implementation hurdles in Indian industries with the help of a structured survey. Identified hurdles are grouped with the help of factor analysis and rated by calculating descriptive statistics. To show the effect of lean implementation hurdles a hypothesis "Organizations having higher level of lean implementation hurdles will have poor (negative) performance" has been postulated and tested using correlation matrix between performance parameters of the organizations and identified hurdles. The findings of the paper will be helpful to prepare road map to identify and eradicate the lean implementation hurdles

Keywords**—**Factor analysis, global competition, lean implementation and lean hurdles.

I. Introduction

IN today's competitive market, manufacturing firms are facing tremendous pressure of customer's expectation about product quality, demand responsiveness, reducing cost and product variety. In order to meet such expectations of customer's production industry is striving for modern manufacturing initiatives and lean manufacturing is one of the best initiatives in that direction. Lean manufacturing as a multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, total quality management (TQM), work teams, cellular manufacturing, Suppliers involvement, etc. in an integrated system. The main thrust of lean production is that these practices can work synergistically to create a systematized, high quality system that fulfils the demands of the customers at the required pace [1]. Lean production is able to manufacture a larger variety of products, at lower costs and better quality, with less inputs, compared to traditional mass production: less human effort, less space, less investment, and less total cycle time as it utilizes optimal skills of the workers, by giving them multiple task, by integrating direct and indirect work, and by encouraging continuous improvement activities [2]

Five principles of lean as given by [3] are:

- Value: The traditional definition of value is the end product that the customer purchases. In the lean model, value is not just the end product, but, the chain of activities that are required to perform in order to produce an end product/end service to be delivered to the customer.
- Value stream: Value is identified through value stream mapping (VSM). This stream is comprised of each step that is performed from raw material to end product and every step is designed, in order to fulfill customer expectations at minimum price. Every role, functions, and responsibilities are designed to make the delivery mechanism more responsive with minimum resources.
- Flow: Flow is the efficiency of the process that transforms raw material into an end product. This involves analyzing every step in the process that touches and does not touch the end product and goal is to provide a continuous flow without any bottlenecks.
- Pull: Traditionally, manufacturing companies built inventories and customers bought inventories. The "pull" concept states that nothing should be built until and unless it is pulled by downstream customer. And the end customer must be the driver of the value stream.
- Perfection: The improvements in the identification of value, the analysis and flow of the value stream, and the pulled product/service can be felt and seen at all levels of the organization.

Reference [4] discussed lean implementation with the help of a case study of Indian manufacturing industry and witnessed 92.58 percent, reduction in lead time, 2.17 percent reduction in processing time, 97.1 percent reduction in WIP and 26.08 percent reduction in manpower requirement. Reference [5] developed an index for measuring leanness of any manufacturing firm based on the scores awarded by leanness measurement team members. They further concluded by calculating leanness index for Indian manufacturing industry that this industry is still deprived of many lean benefits due to the implementation hurdles such as lack of resources and clear implementation strategy involving all levels of organizations. Reference [6] discussed the scope of lean implementation in Indian industries and identified many lean implementation issues in consultation to Indian managers. They also grouped these issues by using principal component analysis.

Reference [7] found a positive and direct relationship between lean manufacturing and productivity in their survey-based research on benefits of lean implementation. They tabulated the benefits accruing from lean manufacturing in

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terms of percentages as improved flexibility (43.18%), improved response time (52.27%), improved quality (59.09%), increased profit (61.36%), decreased inventory (68.18%), reduced waste (81.82%), improved productivity (86.36%) and reduced cost (88.64%).

Reference [8] emphasized that only tools and techniques are not sufficient for successful implementation of lean manufacturing as long as industries are ignoring human factors and lacking clear implementation strategy Lean Manufacturing can bring large scale changes in the organizations if implemented through total involvement of the organization staff from shop floor operator to top management [9]. Reference [10] describes that manufacturers in the Indian industry have always faced discriminating challenges such as increasing customer's expectation, demand variation, and competition in markets After having gone through the extant literature on lean manufacturing and its benefits of manufacturing organizations. It is found that only few examples of lean implementation were noticed in Indian context.

Through this research paper an attempt has been made to identify lean implementation hurdles in consultation with the practitioners and managers working in Indian manufacturing industries. Identified hurdles are grouped with the help of factor analysis and rated by calculating descriptive statistics. Finally, correlation between performance parameters of the organizations and identified hurdles are calculated and found that hurdles are negatively correlated with the performance parameters.

II. Development of Questionnaire

To collect pertinent information for lean implementation from various organizations, a survey-based methodology was used. Extensive visits were made to about twenty organizations in the Manufacturing sector, Machine tools industries and Automobile industries to collect first hand information. On the basis of formal discussion from industry professionals and review of extant literature, a preliminary questionnaire was framed for a pilot survey of forty-two organizations. The final questionnaire was prepared on the basis of information obtained from the pilot survey, followed by interactions with managers, engineers and experts from academic institutions.

The questionnaire was mailed to 550 professionals working in manufacturing sector, machine tools industries and automobile industries. These organizations were selected from various directories available at Confederation of Indian Industries (CII), Auto Component Manufacturers Association (ACMA) of India, Federation of Indian Chambers of Commerce and Industries (FICCI) and Department of industries (Government of India). In spite of continuous reminders, phone calls, e-mail, only 127 valid responses could be obtained. The detailed profile of responding organizations is given in Table I.

III. Lean Implementation Hurdles in Indian Industries

Lean implementation hurdles need lot of attention of the managers and researchers for successful implementation of lean in Indian environment. In this research thirteen lean implementation hurdles have been identified from the extent literature followed by consultation to industrial professionals. With the help of a structured survey these hurdles are rated by the respondents on a five-point Likert scale (1 – Very low, 5 – Very high). To check the internal consistency and reliability, Inter-item analysis is performed and Cronbach's coefficient alpha is calculated, as recommended for empirical research in operations management [11]. The coefficients of Cronbach's alpha for all the issues were 0.898 which exceed the minimum requirements of 0.5 for an exploratory study such as discussed [12].

TABLE I
Profile of Responding Organizations

Type of industry	Respondents Number (%)
Basic Nature	
Manufacturing	51 (40)
Machine Tools	39 (31)
Automobile industry	37 (29)
Investment in plant and equipment (Crores)	
Up to 50	17 (13)
50-100	43 (34)
More than 100	59 (47)
Not specified	08 (06)
According to Product	25(20)
For end used	59(47)
For OEM	26(20)
For end user and OEM not specified	17(13)
According to No of Employees	
UP to 100	42 (33)
100-500	51(40)
More than 500	26 (21)
Not Specified	08 (06)
According to Location	
Rural	05 (04)
Semi urban	40 (31)
Urban	67 (53)
Not specified	15 (12)

A. Descriptive Statistics of Lean Implementation Hurdles

The impact of various lean implementation hurdles on the Indian industry is explained with the help of descriptive statics given in Table II which shows that confusion is the most important hurdle for the implementation of lean in Indian industry (mean value 3.53) and second comes Unstable, un-standardized manufacturing processes (mean 3.48), followed by other hurdles, reduced loyalty is the least important hurdle in Indian industry (mean 2.48).

TABLE II
DESCRIPTIVE STATISTICS OF LEAN IMPLEMENTATION HURDLES

Lean Implementation hurdles	Mean	SD	N
Confusion	3.53	0.94	127
Ego driven decision	3.44	0.98	127
Failure not tolerated	2.95	0.96	127
Favoritism	2.88	0.94	127
Few rewards	3.26	0.87	127
Ignorance	2.79	0.90	127
Lack of resources to implement lean	2.71	0.87	127
Lack of top management support	3.46	0.83	127
Misconception that lean is only for large industries	2.99	0.84	127
Reduced loyalty	2.48	0.88	127
Resistance to change	3.10	1.00	127
Unreliable manufacturing equipment	3.28	0.95	127
Unstable, unstandardized manufacturing processes	3.48	1.03	127

B. Grouping of Lean Implementation Hurdles Using Factor Analysis

A factor analysis was performed to verify groupings of lean implementation hurdles from the survey data. Factors were extracted using the maximum likelihood method, followed by a varimax rotation. The Kaiser criterion (eigenvalues > 1) was employed in conjunction with an evaluation of scree plots. Both the scree test and initial eigenvalue test suggested the presence of three significant factors for lean implementation hurdles that were retained for rotation. This factor analysis empirically grouped the scale items of lean implementation hurdles as given in Table III. The three factors explain 81.54% of the inherent variance in their items. These factors are names as (a) hurdles related to mental barriers which includes: Reduced loyalty, Ego driven decision, Failure not tolerated, Favoritism, Few rewards, Ignorance and Resistance to change (b) hurdles related to lack of awareness which includes: Confusion, Lack of top management support and Misconception that lean is only for large industries and (c) hurdles related to unreliable system which includes: Lack of resources to implement lean, unreliable manufacturing equipment and unstable, unstandardized manufacturing processes.

IV. PERFORMANCE PARAMETERS FOR LEAN IMPLEMENTATION

Performance parameters are the drivers for lean implementation in Indian environment. In this research thirty performance parameters have been identified from the extent literature followed by consultation to industrial professionals. These performance parameters are rated by the respondents on a five-point Likert scale (1 – Very low, 5 – Very high). To check the internal consistency and reliability, Inter-item analysis is performed and Cronbach's coefficient alpha is calculated, as recommended for empirical research in operations management [11]. The coefficients of Cronbach's alpha for all the issues were 0.940 which exceed the minimum requirements of 0.5 for an exploratory study such as discussed [12].

A. Descriptive Statistics of Performance Parameters

The impact of various performance parameters in the Indian industry is explained with the help of descriptive statics given in Table IV, which shows that eliminating inspection of purchased components/raw is the most important performance parameter for the implementation of lean in Indian industry (mean value 3.73) and second comes making inspection effective (mean 3.70), followed by other performance parameters, receiving the best parts from the suppliers is the least important (mean 3.07).

TABLE III
FACTORS SCORES OF LEAN IMPLEMENTATION HURDLES

Lean implementation hurdles	Component		
	1	2	3
Reduced loyalty	0.491	0.803	0.320
Ego driven decision	0.023	0.861	0.240
Favoritism	0.071	0.854	0.244
Few rewards	0.042	0.684	0.497
Ignorance	0.162	0.779	0.367
Resistance to change	0.288	0.577	0.321
Confusion	0.722	0.376	-0.197
Lack of top management support	0.815	0.142	0.414
Misconception that lean is only for large industries	0.743	0.101	0.674
Lack of resources to implement lean	0.229	0.223	0.851
Unreliable manufacturing equipment	0.296	0.033	0.614
Unstable, unstandardized manufacturing processes	0.138	0.099	0.783

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 6 iterations

B. Grouping of Performance Parameters Using Factor Analysis

A factor analysis was performed to verify groupings of performance parameters from the survey data. Factors were extracted using the maximum likelihood method, followed by a varimax rotation. The Kaiser criterion (eigenvalues > 1) was employed in conjunction with an evaluation of scree plots. Both the scree test and initial eigenvalue test suggested the presence of six significant factors for performance parameters that were retained for rotation. This factor analysis empirically grouped the scale items of performance parameters as given in Table V, the six factors explain 85.89% of the inherent

Variance in their items. These parameters are named as (a) Performance related to quality and reliability (b) Performance related to shop floor (C) Performance related to shop floor (d) Performance related to overall satisfaction (E) Performance related to resources management (f) Performance related to market (g) Performance related to overall coordination.

V. RELATIONSHIP BETWEEN LEAN IMPLEMENTATION HURDLES AND PERFORMANCE PARAMETERS

To check the validity of the hypothesis, "Organizations having higher level of lean implementation hurdles will have poor (negative) performance", bivariate correlation between various lean implementation hurdles and performance parameters were calculated. The bivariate correlation results of various lean implementation hurdles and performance parameters using Pearson correlation coefficients are shown in Table VI. Most of these results showed a negative significant

relationship among hurdles related to mental barriers, hurdles related to lack of awareness, and hurdles related to unreliable system with performance related to quality and reliability, performance related to overall satisfaction, performance related to shop floor, performance related to resources management, performance related to market and performance related to overall coordination.

Thus hypothesis "Organizations having higher level of lean implementation hurdles will have poor (negative) performance" is strongly supported and it is proved that organizations having more lean implementation hurdles have poor performance.

TABLE IV
DESCRIPTIVE STATISTICS OF PERFORMANCE PARAMETERS

Performance Parameters	Mean	Std. Deviation	N
Eliminating inspection of purchased components/raw	3.73	1.09	127
Making inspection effective	3.70	1.11	127
Reducing manufacturing cost.	3.38	1.15	127
Receiving the best parts from the suppliers	3.05	1.08	127
Reducing percentage rejection	3.39	1.11	127
Reducing variety of parts	3.32	1.16	127
Improving consumer's satisfaction	3.06	1.09	127
Improving suppliers' satisfaction	3.29	1.21	127
Improving employee satisfaction	3.35	1.16	127
Decreasing idle time of the production line	3.39	1.13	127
Developing capability of diversified production	3.36	1.14	127
Diminishing work-in-progress	3.42	1.16	127
Eliminating temporary storage	3.41	1.16	127
Facilitating flow	3.44	1.19	127
Increasing availability	3.42	1.18	127
Minimizing movement distances	3.43	1.19	127
Minimizing the number of transfer operation	3.24	1.19	127
Optimizing organization subsystem	3.26	1.19	127
Adapting quickly to markets	3.48	1.22	127
Eliminating root causes of faults intrinsically hidden in the assembly operations	3.57	1.17	127
Flexible improvement practices	3.35	1.14	127
Integrated problem solving	3.56	1.15	127
Lean product development	3.53	1.13	127
Quick problem solving cycles	3.45	1.07	127
Reducing employee turnout rate	**3.45**	**1.12**	**127**
Increasing market share	3.43	1.11	127
Profitability	3.43	1.19	127
Punctual part delivery	3.39	1.20	127
Coordinating various organizational sections	3.14	1.14	127
Synchronizing activities	3.16	1.15	127

VI. CONCLUSION

In spite of the fact that lean manufacturing is not a new concept and well documented in extant literature, the irony is that only few organizations have been successful in implementing lean manufacturing in totality and carried out a significant improvement in their performance similar to that of Toyota Motor Corporation (TMC). Maximum of the success stories of lean implementation belongs to developed countries and lean implementation in totality is hardly evidenced in Indian industries but lean manufacturing practices, principles and benefits demonstrated in the literature showed that Indian industry have lot of scope for lean implementation.

TABLE V
GROUPING OF PERFORMANCE PARAMETERS

Performance parameters	1	2	3	4	5	6
Eliminating inspection of purchased components/raw	-0.012	0.049	0.390	0.068	**0.899**	0.009
Making inspection effective	-0.008	0.063	0.391	0.077	**0.898**	0.003
Reducing manufacturing cost.	0.151	0.187	**0.851**	0.037	0.257	-0.093
Receiving the best parts from the suppliers	0.117	0.172	**0.858**	0.047	0.209	-0.209
Reducing percentage rejection	0.085	0.102	**0.868**	0.102	0.260	-0.012
Reducing variety of parts	0.212	0.063	**0.847**	0.136	0.197	0.140
Improving consumer's satisfaction	0.287	0.035	0.191	**0.834**	-0.039	0.098
Improving suppliers' satisfaction	0.582	-0.020	0.067	**0.629**	0.008	0.309
Improving employee satisfaction	0.323	-0.064	0.079	**0.470**	-0.053	0.333
Decreasing idle time of the production line	**0.784**	-0.087	0.382	0.109	-0.046	0.315
Developing capability of diversified production	**0.881**	-0.006	0.264	0.061	0.035	0.148
Diminishing work-in-progress	**0.914**	0.019	0.192	0.008	-0.021	0.088
Eliminating temporary storage	**0.925**	0.068	.142	0.066	-0.006	-0.038
Facilitating flow	**0.934**	-0.014	0.090	0.130	-0.009	-0.041
Increasing availability	**0.918**	0.012	0.046	0.184	0.061	-0.064
Minimizing movement distances	**0.862**	-0.024	0.063	0.343	-0.029	-0.163
Minimizing the number of transfer operation	**0.726**	0.012	0.014	0.522	-0.015	-0.338
Optimizing organization subsystem	**0.681**	0.004	0.006	0.598	0.049	-0.272
Adapting quickly to markets	**0.661**	0.052	-0.003	0.608	0.137	-0.092
Eliminating root causes of faults hidden in operations	0.324	0.194	0.182	**0.820**	0.026	-0.019
Flexible improvement practices	0.203	0.289	0.217	**0.800**	-0.045	-0.067
Integrated problem solving	0.177	0.338	0.165	**0.801**	0.142	0.194
Lean product development	0.044	0.551	0.044	**0.632**	0.080	0.359
Quick problem solving	0.013	**0.824**	-0.043	0.261	0.080	0.320
Reducing employee turnout	-0.010	**0.876**	-0.010	0.227	0.009	0.201
Increasing market share	-0.028	**0.025**	0.063	0.119	**0.894**	0.178
Profitability	-0.013	0.062	0.086	0.089	**0.946**	-0.069
Punctual part delivery	-0.003	0.079	0.152	0.080	**0.924**	-0.069
Coordinating various organizational sections	0.006	-0.260	0.117	0.067	-0.027	**0.896**
Synchronizing activities	0.001	-0.292	0.145	0.078	-0.058	**0.885**

In this research lean implementation hurdles have been identified in discussion with industry personal. The hypothesis "Organizations having higher level of lean implementation hurdles will have poor (negative) performance". is tested using Pearson coefficient of correlation and correlation between performance parameters of the organizations and identified hurdles is found significant at the 0.01 level and .0 05 level (2-tailed, which clearly indicates that identified lean implementation hurdles are negatively correlated with performance parameters. This paper will be beneficial to all the managers and practitioners working in lean implementation and help them to prepare road map to tackle these hurdles.

TABLE VI
CORRELATION MATRIX BETWEEN LEAN IMPLEMENTATION HURDLES AND PERFORMANCE PARAMETERS

	1	2	3	4	5	6	7	8	9
1	1								
2	.713**	1							
3	.623**	.665**	1						
4	-.344**	-.491**	-.463*	1					
5	-.573**	-.313**	-.551*	.273**	1				
6	-.411*	-.404**	-.646**	.543**	.712*	1			
7	-.312*	-.425*	-.636*	.715**	.722*	.891**	1		
8	-.419*	-.606*	-.505**	.633**	.539*	.718**	.816**	1	
9	-.320*	-.424*	-.458**	.756**	.075	.408**	.519**	.362**	1

1.Hurdles related to mental barriers 2. Hurdles related to lack of awareness 3. Hurdles related to unreliable system 4. Performance related to quality and reliability. 5. Performance related to shop floor 6. Performance related to shop floor Performance related to overall satisfaction 7. Performance related to resources management 8. Performance related to market 9. Performance related to overall coordination.

Number shown in tables are Pearson coefficient of correlation, **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed) a List Wise N=127.

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