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Implementation of Lean manufacturing practices and its impact on productivity in Coimbatore foundries

Mr. R. Vinayagasundaram, Dr. V. Kannan
Associate Professors, Kumaraguru College of Technology, Coimbatore – 641 004,

ABSTRACT: *It is very much essential to produce the cast components in foundries with high quality, reliable, consistent and at lowest cost. Hence the foundry owners have to introduce the Lean Manufacturing to improve the productivity. This study brought out how technically qualified entrepreneurs of selected foundries have carried out technological innovations, mainly due to their self-motivation and self-efforts. Introducing the Lean Manufacturing in the process and changing product designs, as desired or directed by the customers resulted in cost reduction, quality and productivity improvement. These have enabled the selected foundries to enhance competitiveness, grow in the domestic market and penetrate the international market and grow in size over time. And have achieved technological innovations successfully based on their technological capability and customer needs, enabling them to sail through the competitive environment.*

There are about 35000 foundries in the world with annual production of 90 million metric tons, providing employment to about 20 lakh people. Indian foundry industry- acknowledged as the world's second largest producer of castings (7.4 Million Tons per Annum - MTPA) based on Tonnage during 2009, next to China (35.2 MTPA). The large gap between India and other nations, along with the fact that the foundry industry is not able to keep up with the local and international demand and to catch up in terms of absolute production quantities and qualities and hence the market share .Having reached this stage, what we need to utilise the potential for growth in our favour. Indian Foundry Industry occupies a special place in shaping the country's economy. India has around 5000 foundries, producing about 7.4 MT of castings worth Rs 20,500 crores. It ranks second in terms of casting production, next to China. These units are mostly located in clusters with numbers varying from 100 to 500 per cluster. Some of the notable clusters are Agra, Howrah, Coimbatore, Kolhapur, Rajkot and Belgaum.

Coimbatore foundries have more export opportunities to tap with growth in the end user segment. Coimbatore foundry cluster has about 620 units and most of them are small-scale. They produce 40,000 to 45,000 tones of castings a month. The foundry product line of Coimbatore cluster is mainly catering to motor pumps, machineries and is slowly emerging to cater to valves and auto components sector from South India. In the last five years, output of the Coimbatore foundries has grown at 15 to 20 per cent and it is estimated that Coimbatore contributes nearly 15 per cent of the total casting production in the country. The total monthly casting production has gone up from about 25,000 ton in 2007 and in 2010 it is 60,000 ton. Almost 20% of the total production goes for exports (direct and indirect) to most of the European countries.

Key Words: *Foundries.. Technology , Lean, Productivity, Profitability, Quality.*

I. INTRODUCTION

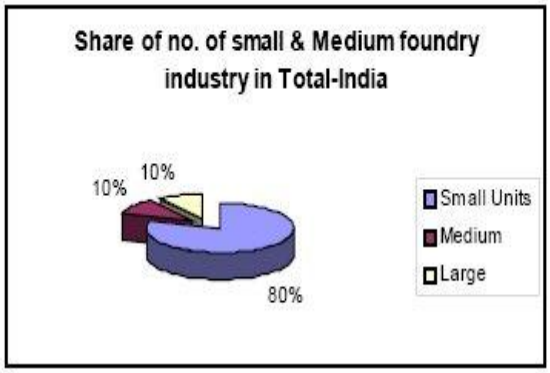
Indian Market

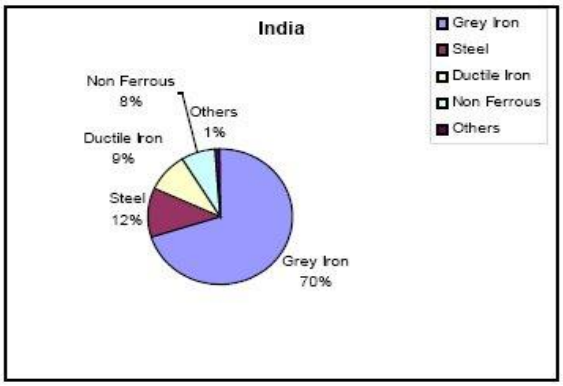
As per Modern Castings USA, India Ranks as 2nd largest casting producer producing estimated 7.44 Million MT of various grades of Castings as per International standards (2009).Ferrous, Non ferrous, Aluminum Alloy, Graded cast iron, Ductile iron, Steel etc. Automobiles, Railways, Pumps Compressors & Valves, Diesel Engines, Aero Industries, Cement, Electric Motors, Tractors and Agriculture implants, Food Processing Industry, Sugar Industry, Machine Tools, Electrical and Textile Machinery, Sanitary pipes & Fittings and Castings for special applications..There are approximately 4500 units out of which 80% can be classified as Small Scale units & 10% each as Medium & Large Scale units. Approximately 500 units are having International Quality Accreditation

Market-segments

Current market for castings : 3 million tonnes per annum.Over 93% of this market is for ferrous castings.Iron castings account for 87.5 % of ferrous castings. Of these, Grey Iron castings account for nearly 90%; Ductile and Malleable castings account for the balance.Non ferrous castings - a small market, primarily used in the auto

sector.Exports as well as imports of castings are not significant; exports in particular have not taken off, primarily because of poor quality of casting supplies from India





Impact of Lean manufacturing practices in Foundry

Lean Manufacturing is also known simply as "lean", it is a philosophy that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination. The seven wastes that are targeted by lean are: overproduction, unnecessary transportation, inventory, motion, defects, over-processing and waiting. The tools, techniques and practices are derived from the Toyota Production System. Lean is a continuously developing philosophy and because it's application is different for each and every company. Lean has had a number of names over the years, developed primarily from the Toyota Production System (TPS) it has been called World Class Manufacturing (WCM), Continuous Flow Manufacturing, and Stock-less production to name a few. Although developed mainly within manufacturing. The lean tools such as 5S or 5C, seven wastes, single minute exchange of die (SMED), Value Stream Mapping etc. are all important parts of lean manufacturing. The lean manufacturing paradigm has been used in an extensive manner at some industrial sectors, like automobile industry, which its assembly lines of components, presents better adaptability to the lean concepts. Applying lean manufacturing concepts in productive processes, and contributes a lot to turn industries more competitive. Lean manufacturing paradigm in the foundry can increase the monthly production; reduce the pouring time. Lead to reduce the waste of time in the process of pouring metal inside the mould, cooling casting, shake-out, and transport to the finishing area, cleaning and cut burr processes. The lean concepts, improves productivity and making the production effective. Lean manufacturing defines seven types of waste that make a production system inefficient and costly.

Need for the study

There is large gap between India and other countries in Productivity, due to non-application of Lean Manufacturing and it has more impact on the Quality, low Productivity and Profitability.
Hence the study will be helpful in identifying the prospects and problems of Indian foundries in applying Lean Manufacturing for improving Productivity.

Objectives

- ✓ To study the implications of implementing Lean manufacturing and its impact on productivity in Coimbatore foundries
- ✓ To study the lean manufacturing practices followed in industries in particular to foundry industry
- ✓ To identifying the prospects and problems of Coimbatore foundries in applying Lean Manufacturing for improving Productivity

II. Research Methodology

The study has been carried out in the medium and large-scale foundries in Coimbatore that have successfully implemented the Lean Manufacturing. In this study, Random sampling is used as sampling technique for getting data from all 94 foundries and every member of the population of interest. As the approach has been directed towards the contributions of initiatives of Lean Manufacturing towards realization of productivity and profitability, a detailed 'Questionnaire' has been designed for accessing the implication of Lean Manufacturing and its impact on productivity and profitability of foundries Totally, there are 580 foundries in Coimbatore in which the small foundry comprises 83 percent (486 foundries), medium foundries 12 per cent (68 foundries) and large foundries comprise five per cent (26 foundries) (Indian Institute of Foundry men, 2011). 42 foundries have been taken for the study. The managers of all the foundries were approached for obtaining details

to find out the implementation of various technology and management tools adopted in medium and large foundries

Exploratory research was adopted for the present investigation. It is the preliminary study of an unfamiliar problem, about which the researcher has little or no knowledge**.** Exploratory research is often conducted because a problem has not been clearly defined as yet or its real scope is unclear. It is aimed to gain familiarity with the problem, to generate new ideas or to make a precise formulation of the problem. Data were collected from the primary and secondary sources. Primary data were collected through questionnaire. Secondary data were collected from the journals, magazines and different websites.

III. Data analysis and Interpretation

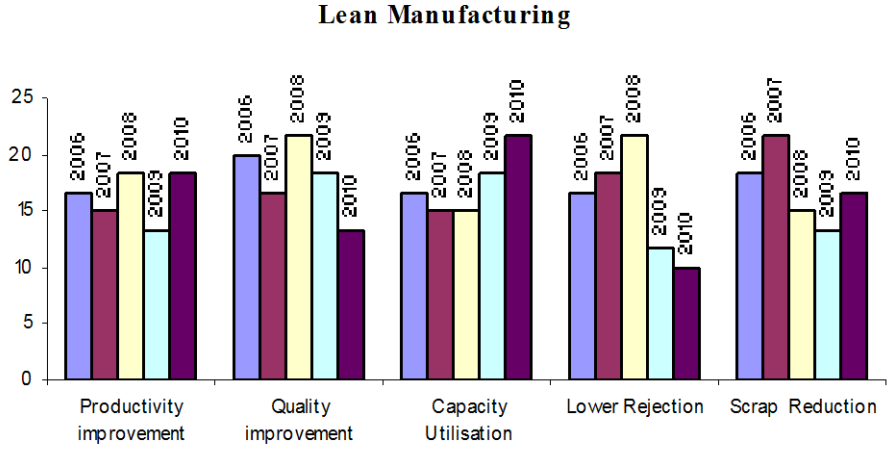
Table-1
Implementation of Lean manufacturing in foundry industry

Year	2010	2009	2008	2007	2006	Total
No of foundries implemented Lean manufacturing	8 (67%)	6 (60%)	7 (64%)	11 (79%)	10 (77%)	42

Table-1 Implementation of Lean manufacturing in foundry industry

Year	Productivity improvement	Quality improvement	Capacity Utilisation	Lower Rejection	Scrap Reduction	Maintenance Reduction	Employee Turnover	Energy savings	Cost Reduction	Increased Turnover
2006	10	12	10	8	8	10	12	7	10	10
2007	11	13	11	9	10	11	12	6	11	10
2008	8	11	8	8	8	8	10	5	8	8
2009	8	10	8	7	7	8	9	6	7	9
2010	10	11	10	10	10	10	10	7	9	10
Total	**47**	**57**	**47**	**42**	**43**	**47**	**53**	**31**	**45**	**47**

Table-2
Reported benefits of Lean manufacturing implementation in 60 foundries (Percent Wise)



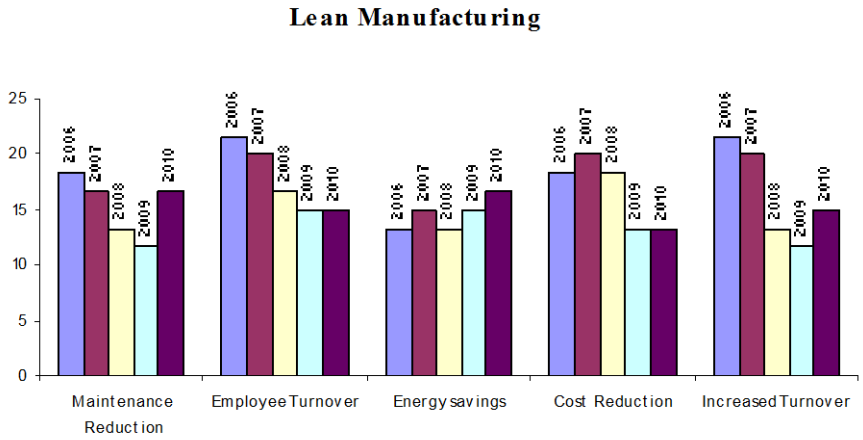


Fig. 2: Benefits of **Lean Manufacturing** implementation in foundries

Chi Square Analysis

Chi square analysis is used to test the association and significant difference between rows and columns of a particular study. Here in this paper rows takes Lean manufacturing technology and columns includes the number of foundries implemented those Lean technologies in the past five years. This analysis after implementation yields a significant value which states that whether there is any association between the variables considered and which one is best in which year.

Hypothesis testing:

Null hypothesis: There is no association between the modern technologies implemented with respect to year considered. But profitability and productivity increases due to modern technologies.

Degrees of freedom-39

Level of significance - 5%

Chi-Square Test: 2010, 2009, 2008, 2007, 2006

Expected counts are printed below observed counts

Chi-Square contributions are printed below expected counts

Lean Manufacturing implementation

2010	2009	2008	2007	2006	Total
8	6	7	11	10	42
8.29	6.66	7.20	10.33	9.51	
0.010	0.065	0.006	0.043	0.025	

Chi-Sq = 4.858, DF = 28, P-Value = 1.000

Statistical Inference:

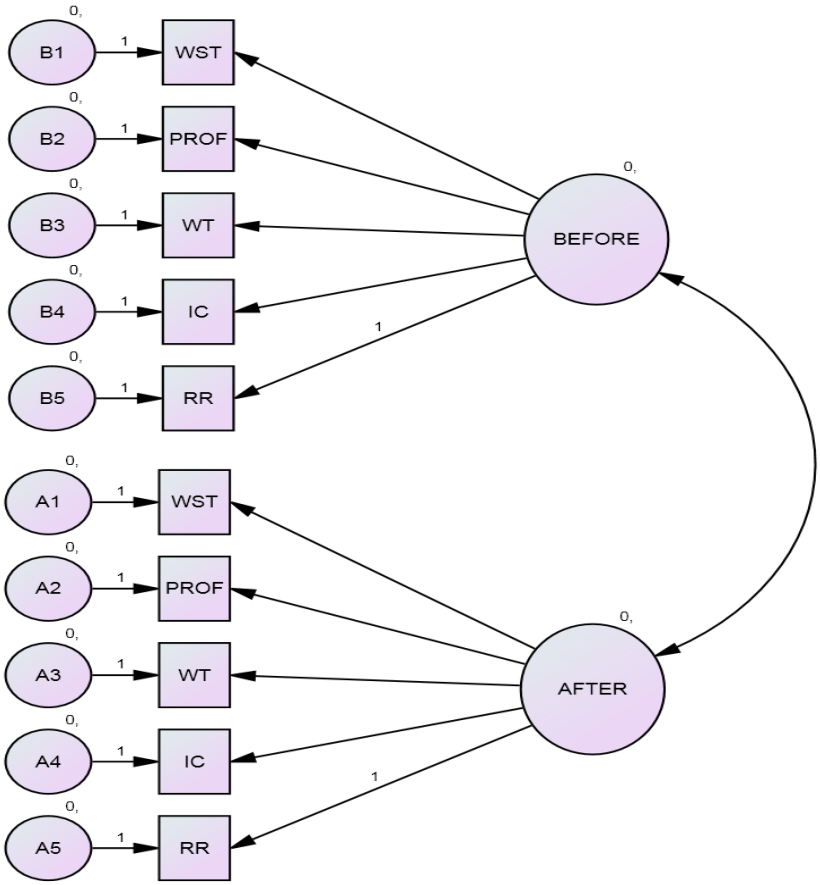
In the above analysis Lean Manufacturing,P-value is the significant value which is greater than the level of significance 0.05. Hence we conclude the null hypothesis is accepted stating that that there is no significant association between rows and columns.

And also from the Wilcoxin signed rank test it is proved that Lean Manufacturing shows higher efficiency in the year 2007.

Due to implementation of modern technology the foundries are benefited and those benefits were ranked as shown below

Sl.No	benefits	rank
1	Quality Improvement	I
2	Productivity Improvement	II
3	Capacity Utilization	III
4	Scrap Reduction	IV
5	Lower Rejection Rate	V

RESEARCH MODEL SPECIFICATION – LEAN MANUFACTURING



Variables specification for implementation of LEAN Manufacturing

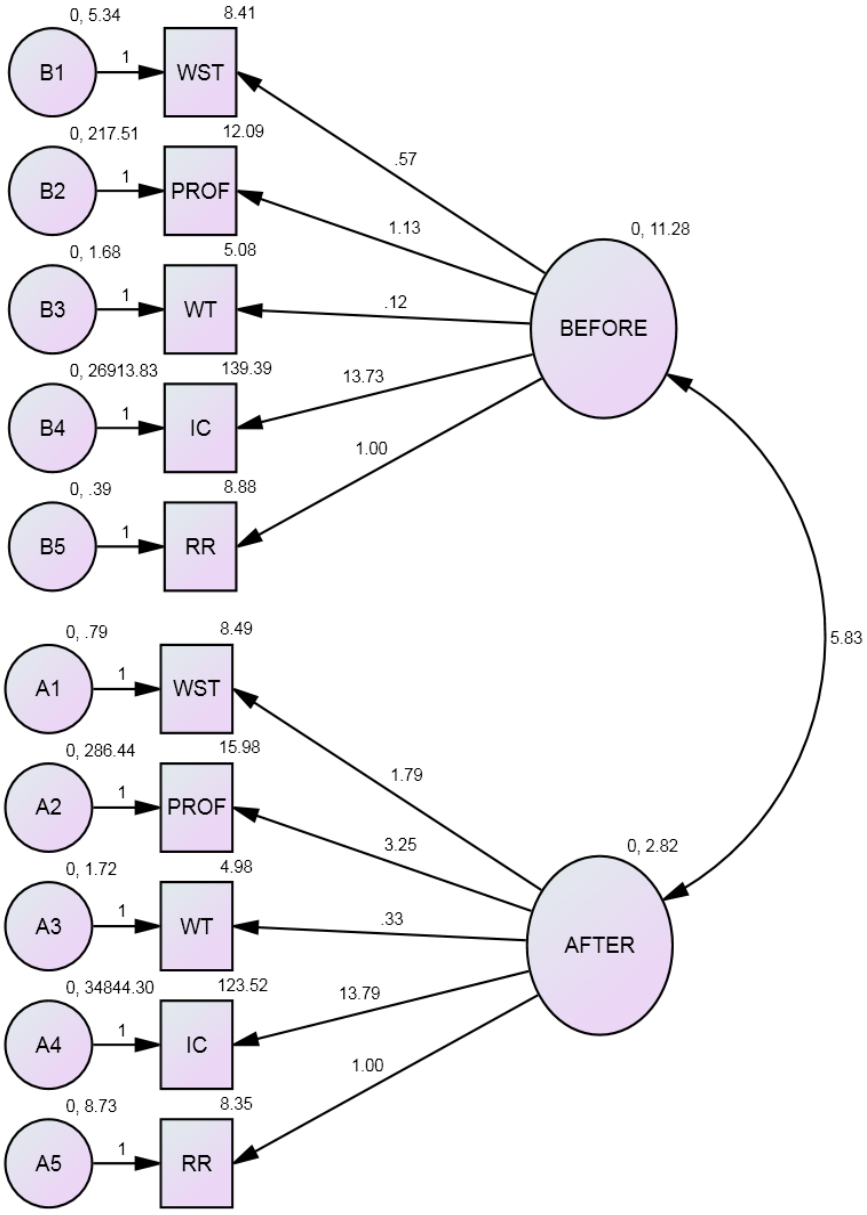
MANIFEST VARIABLES	LATENT VARIABLES
WST =Waste (Percentage)	**Before Implementation**
PROF =Profitability (Rs)	
WT =Waiting time (T)	
IC =Inventory cost (Rs)	
RR =Rejection rate(Percentage)	
WST =Waste (Percentage)	**After Implementation**
PROF =Profitability (Rs)	
WT =Waiting time (T)	
IC =Inventory cost (Rs)	
RR =Rejection rate(Percentage)	

CO-VARIANCE MATRIX – LEAN Manufacturing

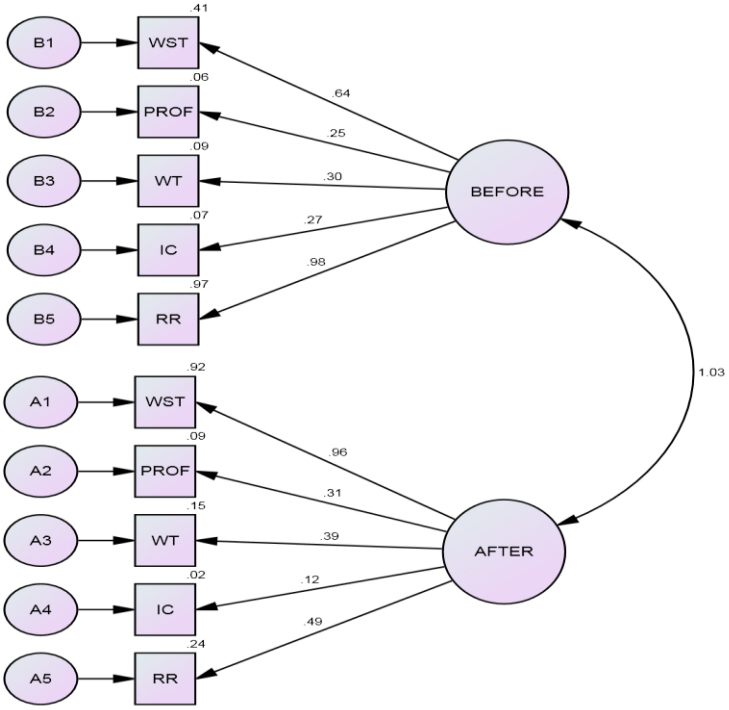
VARIABLES		VARIABLES	
BWST =Waste (Percentage)	**Before Implementation**	AWST =Waste (Percentage)	**After Implementation**
BPROF =Profitability (Rs)		APROF =Profitability (Rs)	
BWT =Waiting time (T)		AWT =Waiting time (T)	
BIC =Inventory cost (Rs)		AIC =Inventory cost (Rs)	
BRR =Rejection rate(Percentage)		ARR =Rejection rate(Percentage)	

UNSTANDARDISED ESTIMATES – LEAN Manufacturing]

	BWST	BPROF	BWT	BIC	BRR	AWST	APROF	AWT	AIC	ARR
BWST	8.988823									
BPROF	16.40161	231.9736								
BWT	2.025693	10.587	1.836261							
BIC	0.830019	1784.822	82.72652	29040.62						
BRR	6.458993	12.18427	1.395703	128.9983	11.67223					
AWST	5.689215	9.771376	1.127014	143.4963	10.44506	9.840325				
APROF	9.39754	179.9031	5.382417	1976.764	18.756	16.03116	316.2181			
AWT	1.744811	6.568878	0.761068	48.6358	1.912759	1.638409	14.03007	2.023516		
AIC	107.1613	1812.027	30.0045	16747.03	93.8817	91.00915	2765.063	131.9281	35380.73	
ARR	6.206271	14.99476	0.645232	23.17855	5.632458	4.706924	13.99988	2.33372	254.2286	11.55262



STANDARDISED ESTIMATES – LEAN Manufacturing



Testing of Hypotheses– STANDARDISED ESTIMATES - LEAN Manufacturing

The following table represents the results of the testing of the hypotheses.

TESTING OF HYPOTHESES

Hypotheses	Hypothetical Relationship	Result
H1: There is a positive impact of WST and after implementation of LEAN Manufacturing.	Positive	Confirmed
H2: There is a positive impact of PROF and after implementation of LEAN Manufacturing.	Positive	Confirmed
H3: There is a positive impact of WT and after implementation of LEAN Manufacturing.	Positive	Confirmed
H4: There is a positive impact of IC and after implementation of LEAN Manufacturing.	Positive	Confirmed
H5: There is a positive impact of RR and after implementation of LEAN Manufacturing.	Positive	Confirmed

Chi-square = 5520.2 Degrees of freedom = 55, Probability level = .000

Discussion of the result

From the path diagram, all the measured variables with latent variable of successful operation LEAN Manufacturing has positive relationship and also significant at 1 percent and 5 percent level after implementation of lean technology.

REGRESSION WEIGHTS FOR IMPLEMENTATION OF LEAN MANUFACTURING LISREL MAXIMIM LIKELIHOOD ESTIMATES

Latent Variable		Measured Variables	Estimates	SE	R^2	CR	P
BEFORE	<---	BWST	11.282	1.844	.64	6.118	***
BEFORE	<---	BPROF	2.823	1.167	.25	2.419	.016
BEFORE	<---	BWT	.391	.292	.30	1.338	.181
BEFORE	<---	BIC	26913.825	4237.359	.27	6.352	***
BEFORE	<---	BRR	1.676	.263	.98	6.380	***
AFTER	<---	AWST	217.511	34.009	.96	6.396	***
AFTER	<---	APROF	5.345	.846	.31	6.320	***
AFTER	<---	AWT	8.730	1.351	.39	6.463	***
AFTER	<---	AIC	34844.298	5449.671	.12	6.394	***
AFTER	<---	ARR	1.718	.269	.49	6.394	***

*****- Significant at 1% level**

The above table shows the regression coefficient of the exogenous variables. It is noted that the critical ratio of all the variables are above the table value 2.962 and it is significant at 1 percent level except BPROF and BWT.

Hence, the selected variables are the most influenced factors for after implementation of LEAN Manufacturing.

IV. Conclusion

Indian industries need overall operational excellence in today's era of global competitiveness. Especially, the basic manufacturing sectors such as foundries and other metal working/forming industries need breakthrough improvements in quality as well as in productivity. Indian foundry industry faces great challenges and requires advancement in productivity, quality and cost competitiveness to increase its domestic and world market share. A key notion of success in a highly competitive business is not just getting the orders but processing the orders effectively with high quality and profitability by implementing modern technologies and management methods. This key concept of important technology was put to test through an empirical approach in this study and this view is exactly endorsed by the results of this study. Growth efforts of the Coimbatore foundries have been on the lines of introducing advanced technology, expansion of local market, entry into foreign markets through up gradation of quality castings and productivity. Foundries do not see the need for technical assistance due to fear of divulging company information. Therefore, efforts such as this study will give a view on the technology support required by the foundries for increasing the productivity and profitability.

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