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Enigma of Casting Technology Awareness in Manufacturing Industry of Northern India

Jagdeep Singh[1, 2] and Harpuneet Singh[3]

[1] Research Scholar, Department of Mechanical Engineering, I.K. Gujral Punjab Technical University, Kapurthala, Punjab, India

[2] Assistant Professor, Department of Production Engineering , Guru Nanak Dev Engg. College, Ludhiana, Punjab, India

[3] Assistant Professor, Department of Production Engineering , Guru Nanak Dev Engg. College, Ludhiana, Punjab, India

Abstract

The impact of new technologies is lower in India as compared to the developed countries. The present study is new technology awareness of casting/foundry process in Auto parts industries. The main objective to conduct this study is to find the level of awareness in new techniques/standards and the defects occurred in the casted products in industry .Survey has been done in 39 Auto parts (casting process) industries of Northern India. Descriptive statistics, ANOVA and post hoc test applied to analyze the collected data. After performing examination it has been establish that medium scale industries most aware of techniques used in casting process as compared to the small and micro scale industries. Most awareness in micro & small scale industry were Microstructure control of casting and in medium scale was Centrifugal casting technology. Major defects found in micro, small and medium industries were chilled surface, blow holes/pin holes and parting line respectively.

Keywords: *Technology awareness, ANOVA, Post Hoc test, MSMEs.*

1. Introduction

Technology may be defined is the usage and knowledge of tools, techniques, and crafts. Technology awareness is very helpful for the optimizations of the casting process. In the casting the pattern design and manufacturing is very expansive because it consume so much time, labour and also material. With the help of technology awareness in the casting industries we can increase the quality of mould so that we can get good casted products and hence increase the productivity and cost effectiveness of the casting

Casting is a manufacturing process in which a liquid material is usually poured into a mould, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mould to complete the process. Casting Processes are classified as Sand Casting, Die Casting, Shell Casting, Permanent Casting, Investment Casting (Lost wax Casting), Lost-foam Casting, Centrifugal Casting.

Majority of the auto parts industry uses sand casting and for no ferrous casting centrifugal casting in some industries. Micro, Small and Medium Enterprises (MSMEs) form the backbone of the auto component industry in India. According to the newly enacted Micro, Small and Medium Enterprises Development Act 2006, enterprises are classified into Micro, Small and Medium as shown in following Table 1.

Table 1: MSMEs classifications according to investment

Type of enterprise	Investment in plant and machinery
Micro	Up to Rs. 25 Lac.
Small	More than Rs. 25 Lac, but does not exceed Rs. 5 Crore
Medium	More than Rs. 5 Crore but does not exceed Rs.10 Crore

For the present study first literature review on casting technology, ANOVA test and post hoc was done, build questioner with the help of previous studies and experts from industry & Academia, which illustrates the casting technology/standards

and defects occurred in MSMEs' for technology awareness. After that list of auto parts manufacturing MSMEs of Punjab prepared which are contributing major part in the manufacturing of auto parts in Northern India. Next, we explain data collection and research sampling. After that the research findings are presented, in the last part briefly summarizes the research findings.

The assessment of advanced manufacturing technologies (AMTs) managed in Indian MSMEs of the machinery, automobile, process sectors and electronics. The study was carried out to evaluate the position of AMT, pinpoint competitive priorities, identify AMTs relevant to Indian MSMEs, AMT execution criteria, and evaluate the amount of asset in AMTs. Replies from 122 enterprises were examined. It was detected that Indian MSMEs were giving the utmost importance to quality and the minimum importance to flexibility (Dangayach and Deshmukh, 2005) [3]. Bernburg (2008) studied the effects of 3d virtual reality with 2d stimulations and by means of dummy entities. One way ANOVA and post hoc test was used. The results revealed that 3d virtual reality had more influence on consumer as related to other entities [1]. Singh and Khamba (2010) surveyed an enormous number of engineering organizations to establish the influences prepared by success elements of AMTs on the way to understanding manufacturing enactment perfections. The associations between enablers of AMTs' utilization and manufacturing enactment factors was appraised in addition to that endorsed by retaining different statistical techniques. The study was focused on significant influences of AMTs' success factors viz.: rewards and recognition to personnel; interdisciplinary team construction; education & training of personnel; and institute-industry collaboration on the way to affecting enhancements in manufacturing enactment in Indian engineering organizations. The inter-relationships among different AMTs' utilization success elements with the manufacturing enactment factors was assessed [8]. Tuanmat and Smith (2011) investigated fluctuations in manufacturing technology, competitive environment, and organizational strategy in small and medium Malaysian engineering enterprises. A survey technique was used to collect the data from the enterprises in the Klang Valley. The research showed that the majority of responding industries have acknowledged changes in their industry atmosphere and advanced manufacturing technology, which have impacted on organizational strategic behavior. Structural equation modeling revealed positive associations among competitive environment, manufacturing technology, and organizational strategy, with a positive impact on enactment [10]. Kumar et.al (2013) established variables that are very dynamic to set up the lean tools in Indian Automotive Industries. Hypothesis model was made and from the survey effects were attained, which establish 9 independent variables and 9 dependent variables which affects the lean manufacturing [5]. Chaple et.al (2014) obtained the calculation of the lean manufacturing tools in Indian Industries. Enablers and Obstacles were found. Approaches which were used in executing the lean tools were also recognized [2]. Loha and sukto (2015) studied the purpose of lean manufacturing tools in small and medium industries of two industries in Northeast of Thailand (shoe and garment industry). The results revealed that 30% of lean manufacturing was done in shoe firms and 34% of lean manufacturing was done in garment firms [6]. Singh and Ubhi (2016) conducted study in 80 Auto parts industries. One way ANOVA and post hoc test used to analyse the data. The results showed that medium scale enterprises use more amount of lean tools as related to the small and micro scale enterprises. Utmost significant lean tool used in micro, small and medium were visual factory, PDCA and smart goals correspondingly. Obstacles and benefits were also establish for all type of enterprises. Major obstacles established in MSMEs were lack of communication, attitude of shop floor administration and degree of investment respectively. Main benefits desired by micro, small and medium scale enterprises were lead time reduction, decrease in cost and decrease in scrap correspondingly [9]. Nath and Sarkar (2017) performed an exploratory study for evaluation and implementation of new technologies. Two different fuzzy based MCDM was applied to capture the issue of uncertainty in AMT implementation. A case example of technology evaluation was presented to show the effectiveness of proposed methodology [7]. Kumar et al., (2017) explored the relationship between success parameters and execution of advanced manufacturing technology (AMT) and examined the changes required in manufacturing system as a result of new technology execution. It concluded that success factors are positively related to the AMT implementation. The redesign of the production system and organization strategy is directly related to the AMT implementation. The notable finding is the AMT implementation has no direct impact on the redesign of human resource, but it has mediated impact through the production system. In the present framework, important 75 parameters, which are related to the utilization of new technologies are considered [4].

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2. Research Methodology

The methodology for the present work is shown in the figure 1.

2.1 Selection of Industries

For set up new technologies auto parts enterprises had extra potential than other type of enterprises, majority of the parts made by casting process, so these type of industries were selected. Total population was selected from Auto Parts manufacturing association Ludhiana, Jalandhar and Phagwara cities of Punjab (Northern India). The list of companies selected randomly from the Directorate of Industries and membership of the Confederation of Indian Industry.

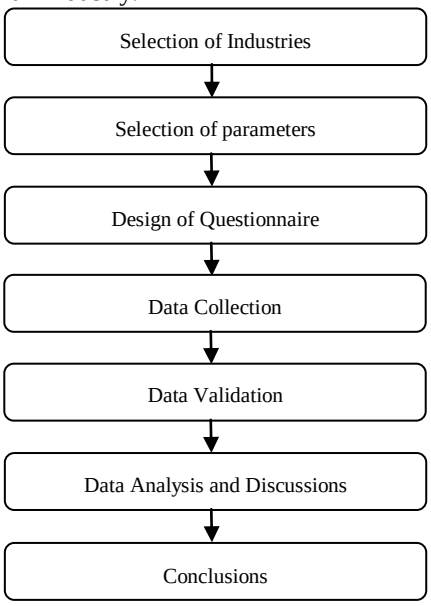

Fig. 1 Methodology for the present work

Table 2: Distribution of samples and respondent rate of industries.

City	Sample Size	Number of industries respond	(% of total)
Ludhiana	75	19	40%
Jalandhar	33	11	40%
Phagwara	32	9	40%
Total	140	39	

2.2 Selection of parameters

After studying previous research works, Brainstorming and Industrial & academicians experts improvise, 09 parameters (new technology) were selected which effect the casting process and 06 defects were identified which affect the quality and productivity of casted products

2.3 Design of questionnaire

A pilot survey study was done with the help of industry professionals and researchers to inspect the content validity of the questionnaire. The 5-point Likert scale was applied to gather the data.

2.4 Data Collection

The final questionnaire was sent randomly to 140 auto parts manufacturing Industries. The gentle follow up, and personal visit to few Industries was also made to collect the data. Most of the respondent's position belongs to the upper level of administration that comprised executives, general managers, directors etc. The surveys having incomplete information and more than one response from an industry were dropped and finally, the survey involved, a total of 39 questionnaires collected from different auto parts manufacturing Industries. The response rate was 29 %, Out of these 19, 11 and 09 from Ludhiana, Jalandhar, and Phagwara respectively.

2.5 Testing of normality

The normality of collected data should be checked, before an investigation of data to examine distribution pattern of data (Kuo et al., 2009). skewness and kurtosis values are used to check the normality of data, the acceptable range of univariate skewness <3 and kurtosis <10 (Hair et al., 2010). The values of skewness and kurtosis of all collected data fell within the adequate range

2.6 Design Validation

Cronbach's alpha test was applied to 39 industries. The acceptable range of Cronbach's alpha coefficient for the valid questionnaires should be in the range of 0.7-1. In the present work, this range was 0.785, which was acceptable. SPSS 20 software was used to validate the current data.

3. Data Analysis and Discussions

3.1 Type of Industries

Table 3 shows the type of Auto parts industries in Ludhiana. 36 percent industries were small scale industries and 31 percent industries were medium scale.

Table 3: Type of industries

Industry type	Percentage of Industries
Micro Scale	31
Small Scale	33
Medium Scale	36

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3.2 Number of Employees

Table 4 displays the number of personnel employed in enterprises. Out of total 69 percent industries having less than 300 employees and 8 percent have more than 1500 employees.

Table 4: Employees working in industries

Number of Employee	Percentage of Industries
<300	69
301-800	20
800-1500	3
>1500	8

3.3 Market Channel

Table 5 shows about the Market channel of various industries out of total 77% supply products in local market and 23 % export the products.

Table 5: Market Channel

Market Channel	Percentage of Industries
Domestic	77
Export	23

3.4 ISO-9000 certified

Table 6 shows Majority of the industry have quality conscious and have quality certification. Out of total 89% industries have ISO certification and 11 % don't have.

Table 6: ISO certification

ISO-9000 certified	Percentage of Industries
Yes	89
No	11

3.5 Awareness in Casting/Foundry Technology

Figure 2 shows about the awareness in Casting/Foundry Technology. Likert scale was used for checking the awareness level in Casting/Foundry Technology achieved by industries ranging from not at all as 1 to a large extent as 5.

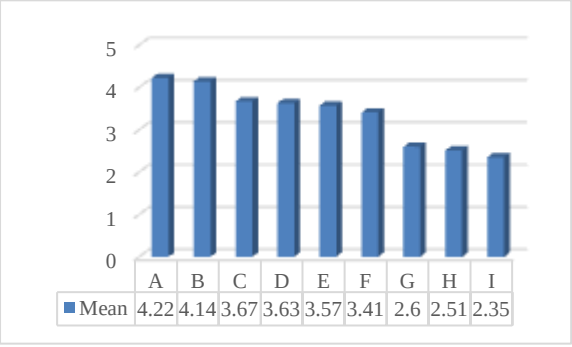

Fig.2 Awareness in Casting/Foundry Technology

On the basis of these findings the parameters can be ranked in Table 7 according to their importance. It shows that majority of MSMEs are aware of Indian Standard for casting materials (ferrous & Nonferrous) and less aware of Standardization of open tolerances.

Table 7: Ranking of awareness level Casting/Foundry technology

Code	Casting/Foundry	Mean
A	Indian Standard for casting materials (ferrous & Nonferrous)	4.22
B	Testing of sand and mould	4.14
C	Spectrometric of control of casting	3.67
D	Microstructure of control of casting	3.63
E	Temperature control of molten metal at the ladle level	3.57
F	Mechanical testing of casting	3.41
G	Furnaces temperature controlled	2.60
H	Centrifugal casting technology for nonferrous casting	2.51
I	Standardization of open tolerances	2.35

3.6 Defects in the casting

Figure 3 shows about casting which causes rejection in casted products. Likert scale was used for checking the rejection level in Casting/Foundry Technology achieved by industries ranging from 1-5 percent as 1 to 20-25 percent as 5.

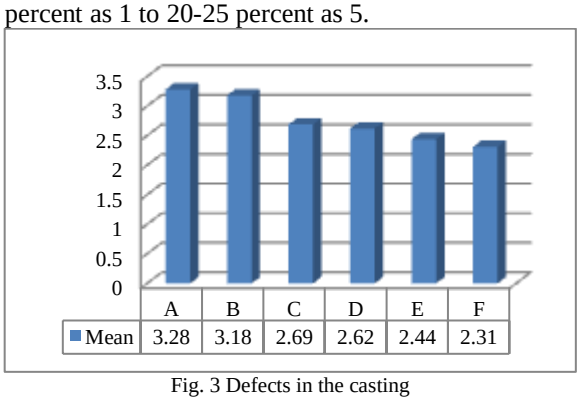

Fig. 3 Defects in the casting

On the basis of these findings the parameters can be ranked in Table 8 according to their importance. Major defects faced by MSMEs are blow holes/pinholes and less occurred defect are defects on parting line.

Table 8: Defects in the casting

Code	Casting/Foundry	Mean
A	Blow holes/pinholes	3.28
B	Chilled surface	3.18
C	Surface finish	2.69
D	Defects on parting line	2.62
E	Hardness	2.44
F	Shrinkages	2.31

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3.7 Significant difference in the level of technology awareness and defects occurred in the casting

For finding the significance difference between and within group's One way ANOVA test was used. Three hypothesis were set for checking the awareness level of technology between MSMEs, Which the given below:

Ho = There is no significance variance of technology awareness between MSMEs.

H1 = There is significance variance of technology awareness between MSMEs.

H2 = There is significance variance of occurrence of casting defects among MSMEs.

Ho will be accepted if the significance value is larger than .05 and H_1 and H_2 will be accepted if the significance value is less than .05.

3.8 Significant difference in the level of technology awareness in MSMEs

ANOVA test shows the significant parameters for Casting/Foundry Technology Awareness. Out of the 9 technology attributes 5 were showed significant difference in the level of awareness. These are 1. Furnaces temperature controlled, 2. Temperature control of molten metal at the ladle level, 3. Standardization of open tolerances, 4. Microstructure of control of casting, 5. Centrifugal casting technology for nonferrous casting.

3.8 Significant difference in the defects occurred in the MSMEs

All the parameters are Significant for Casting/Foundry defects.

3.9 Student Newmann keuls[ab] Test

After finding the significant factors, Student Newmann Keuls test was applied to find that where the significance difference arises. Only on significant factors this test was applied. The subset columns shows the average values of enterprises. If all the values are in same column it represents that there is no statistically variance if the values are in different columns then there is statistically variance between them. The value of a (harmonic mean) for casting is 12.949 Value of b = Group sizes are not identical and harmonic mean of size is used.

3.10 Comparison of casting technology awareness

This test was applied to the 5 casting/foundry technology attribute to see the level of awareness in the MSMEs. Lowermost average value is signified on topmost of the table while utmost at bottommost of the table. First of all applied in the temperature controlled furnaces whose results are shown in table 9.

Table 9: Result of temperature controlled furnaces

Type	N	Subset for alpha = 0.05	
		1	2
Micro-Scale	12	1.88	
Small-Scale	13	2.25	
Medium-Scale	14		3.00

Medium scale enterprises have maximum awareness of temperature controlled furnaces with average value 3.00 however micro scale enterprises have minimum awareness with average 1.88. Similarly same examination was applied to other significant elements. The mean values of all the factors are shown in figure 4.

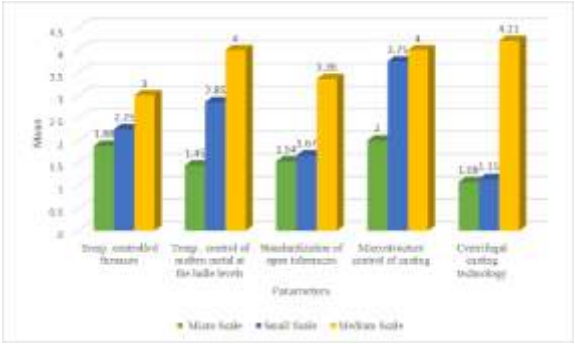

Fig.4 Comparison of casting technology awareness

Figure 4 shows the following results:

1. Most common awareness in micro scale industries are Microstructure control of casting with mean value 2.00, Temp. controlled furnaces with mean value 1.88 and Standardization of open tolerances with mean 1.54.
2. Most common awareness in small scale industries are Microstructure control of casting with mean value 3.75, Temp. control of molten metal at the ladle levels with mean value 2.85 and Temp. controlled furnaces with mean value 2.25.
3. Most common awareness in medium scale industries are Centrifugal casting technology with mean value 4.21, Temp. control of molten metal at the ladle levels with mean value 4.00 and Microstructure control of casting with mean value 4.00.

3.11 Comparison of casting defects

Comparison of defects faced in the casted products by industries, from the Student Newmann Test is shown figure 5.

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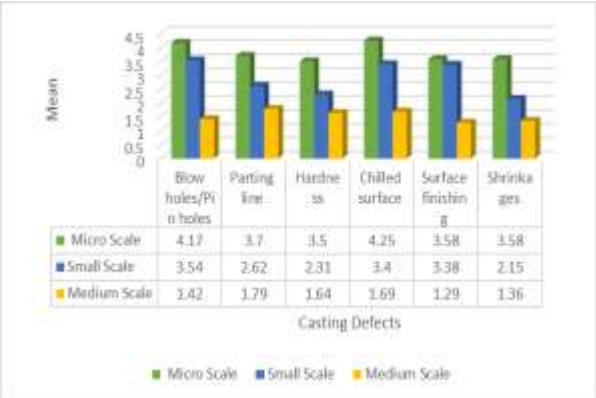

Fig.5. Comparison of casting defects faced by Industries

From the figure 5 following three results were observed:

1. Most common defects in casting process faced by micro scale industries are chilled surface with mean value 4.25, blow holes/pin holes with mean value 4.17 and parting line with mean 3.70.
2. Most common defects in casting process faced by small scale industries are blow holes/pin holes with mean value 3.54, chilled surface with mean value 3.40 and surface finish with mean value 3.38.
3. Most common defects in casting process faced medium scale industries are parting line with mean value 1.79, chilled surface with mean value 1.69 and hardness with mean value 1.64.

4. Conclusions

India is in the process of improving its economy through its prosperous MSMEs. These enterprises need to introduce new technologies in their industry processes, especially in their manufacturing activities. The current research findings can also contribute to the development of MSMEs casting technology awareness in other developing countries. This study introduces the new age and explores the casting technology awareness levels and defects faced by MSMEs of northern India.

Majority of the Casting/Foundry industries are aware of Indian Standard for casting materials (ferrous & Nonferrous).

Most common defect faced by industries are blow holes/pin holes in the casted products.

Awareness about Casting/Foundry technology by MSME's are:

Micro scale: Microstructure control of casting, Temperature controlled furnaces and Standardization of open tolerances.

Small scale: Microstructure control of casting, Temperature control of molten metal at the ladle levels and Temperature controlled furnaces.

Medium scale: Centrifugal casting technology, Temperature control of molten metal at the ladle levels and Microstructure control of casting.

Defects faced by MSME's are:

Micro scale: Chilled surface, blow holes/pin holes and parting line.

Small scale: Blow holes/pin holes, chilled surface and surface finish.

Medium scale: Parting line, chilled surface and hardness.

The main drawback of this study derives from the different types of requirements for new technology awareness. Future research should expand this study to other type of manufacturing technology like forging, machining, heat treatment etc. Finally, MSME atmospheres may vary through different nations. Thus, future research should make cross-country relationships to improve the generalizability of this study.

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