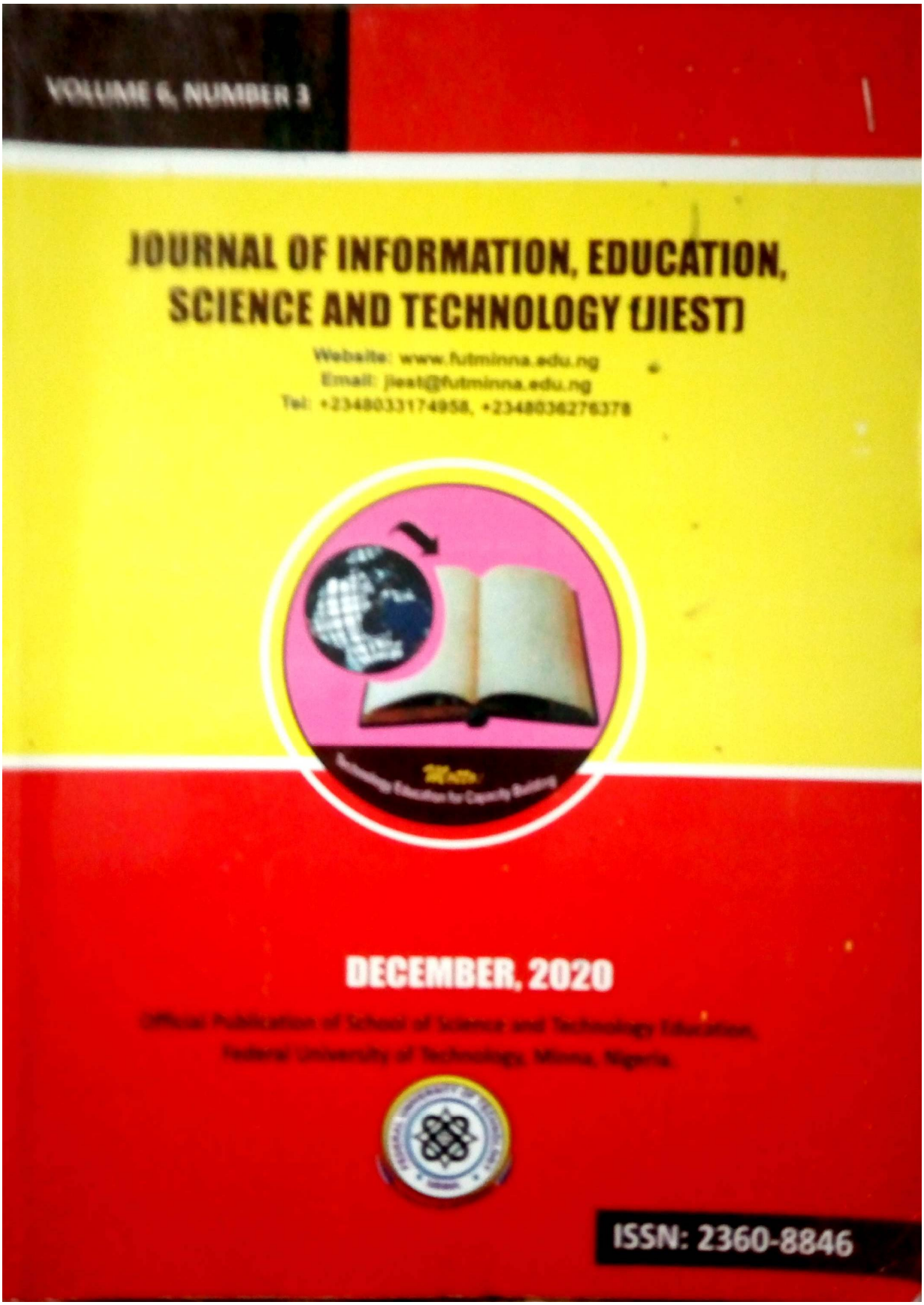
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TECHNIQUES FOR STANDARDIZING MOULD PREPARATION PRACTICES IN LOCAL METAL CASTING OPERATIONS IN KANO STATE, NIGERIA

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Abstract

This study investigated techniques for standardizing mould preparation practices in local metal casting operations in Kano State, Nigeria. Two research questions and two hypotheses guided this study. The study adopted descriptive survey research design. The population for the study was 1551 respondents, comprising of 1500 Foundry artisans, 35 Metalwork Technology Industrial Personnel and 16 Metalwork Technology Lecturers. Out of the 1500 artisans, 316 was sampled using Taro Yamane formula. Therefore, a total of 367 respondents were used for the study. Out of the 367 questionnaire administered, only 351 was returned making a percentage instrument return rate of 95 percent. The instrument for data collection was a 36 items questionnaire. Three lecturers validated the questionnaire and the Cronbach's Alpha reliability index of the questionnaire was 0.92. Mean and Standard deviation was use to answer the research questions while one way Analysis of Variance (ANOVA) was use to test the null hypotheses at 0.05 level of significance. Findings revealed among others that the techniques for standardizing mould preparation practices are: use of Computer Aided Design in pattern construction, use of simulation software to predict properties of cast product as well as use of electronic digital moulding equipment while the techniques for standardizing safety precautions in mould preparation practices are : strict adherence to safe operating procedures during mould preparation activities, regularly inspecting foundry workers at each stage of mould preparation as well as using the appropriate mould preparation tool for specific task. Recommendation was made to create awareness of the various techniques that are used for standardization and the need to encourage the stakeholders to adhere strictly to these techniques to enhance quality and safe work practice in mould preparation in Kano State, Nigeria.

Keywords: *Foundry, Techniques, Mould Preparation, Practices, Metal Casting.*

Introduction

Casting is a manufacturing process which involves melting the metal and pouring the molten metal into a prepared mould where it solidifies as a casting whose shape and size are replicate of the mould cavity. Casting is a process of forming metal objects by melting metal and pouring it into moulds. It is the use of liquid metal to cast the shape of the object directly, producing cast metal. Castings obtain their shape principally when molten metal solidifies in the desired form. According to Tukura and Paiko (2008), casting remains one of the world basic industry and has been considered one of the most important activities. This is because all other methods of forming or shaping objects, cast products remains the cheapest, the simplest in the production of not only automobile components, but other general parts. As can be recognized from the definition, casting is essentially a simple, inexpensive and versatile way of forming, so it is not surprising that, it was historically the first method used as certain advantages are inherent in the metal casting process.

Casting process, according to Ohnaka (2015), are broadly categorized into mould preparation (mould creation) and metal handling processes. The mould creation process in its simplest form involves the designing of the pattern of a given shape; creation of refractory mould containing the designed pattern; as well as core making. Ohnaka added that the metal handling process is concerned with heating of the metal (Melting process), filling the mold cavity with molten metal (Pouring process), allowing it to solidify (Solidification process) removal of casting from the mold and cleaning, finishing and inspection of the metal cast component. Obviously, each step depends on the one proceeding it as well as one succeeding it as casting process becomes complex requiring the use of standardized techniques that came about due to rapid technological advancement in metal foundry with Metal Handling Process being governed by such complex laws of physical chemistry. One of the most critical aspects of Metal Handling Process is the solidification techniques especially in traditional casting.

Recent development in casting techniques such as the use of Computer Aided Engineering (CAE) has been transforming the heavily experience-dependent foundry technology into a modern and science-based one. Modeling and Simulation are now crucial techniques in standardizing both Mould Creation Process and Metal Handling Process in foundry Industries and they have been progressing toward Integrated Computation Materials Engineering (Meehanite, 2015). This may be achieved by adding multi-scale-analysis for estimation of solidification structure and performances, and by combining various process simulation such as molding and heat treatment in a safe working environment.

The casting working environment present dangerous condition, particularly around furnace and other equipment used in Mould Creation and Metal Handling Practices in casting operations. Typical foundry process involving molten metal are carried out at high temperatures, may emit toxic fumes, produce noise and present other hazardous conditions (Anshika, 2017). This condition makes metal casting a dangerous line of work for foundry professionals as improvements in the techniques for standard Mould Creation and Metal Handling Practices come with new safety measures to be observed which poses the need to find out techniques for standardizing safety practices in casting operations. This is more so as most of the major components of machine tools, power plants, industrial machinery and equipment, automotive, agricultural as well as textile industries are products of the foundry. Hardly can you think of any major machine or equipment which has no components that have been cast in a foundry.

One can therefore rightly say that the discovery and acquisition of modern foundry technology such as standardized metal casting techniques is basic to economic development and self-reliance in developing countries like Nigeria where little attention has been paid to the development of the casting industry for too long (Edwin, 2017). Kano state is the second largest industrial center in Northern Nigeria with characteristic textile, footwear, cosmetics, plastics, pharmaceuticals and metal foundry industries among many others. The increase of metal casting industries, and the concern of stakeholders in metal foundry indicates the need for the standardization of the casting towards minimizing unemployment and perceived high level of poverty in the state (Akinoso & Raji, 2011). There is no doubt that modern civilization would not be advanced as it is today if it were not for the metal casting and its product in the developing world of today.

The metal casting industry is progressive and is always looking ahead; hence, as it improves, so will civilization improve. Industrial development has been frequently brought into special prominence in Kano State Government Development Plan (KNSG, 2016). For example, the government frequently gives loans to small scale industries. Unfortunately, there seem to be continuous collapse of metal work industries and consequent high rate of importation of metal parts in Nigeria, particularly in Kano State (Liman & Adamu 2015). This problem may be partly blamed on the use of outdated and substandard techniques in the mould preparation practices in local metal casting operations in Kano State. Hence, the need to find out the techniques for standardizing mould preparation practices in local metal casting operations in Kano state, Nigeria.

Statement of the Research Problem

Today, nearly every mechanical device we use, from automobiles, farm implements, machine parts, washing machines, cooking utensils are manufactured using metal parts that were created in the casting process, the difference between todays cast metal products and those that were manufactured even 100 years ago is the precision and tolerances that can be achieved through the modern techniques for standardizing metal casting processes. Throughout the centuries, various combinations of raw materials have been developed to produce various metal types. The assembling of industrial metal cast by products such as machine parts, cooking pots farm implements and automobile parts for industries in the country generated so much wealth in the past, but the actual industrial production within the country now is going at a slow face (Ohnaka, 2015).

In Kano, there is a growing concern about having increasing substandard metal casting products such as grinding machine disc, cooking utensils and so on that are made locally. Literature review shows that the markets for this products are depreciating by the day as metal casting products made locally cannot compete with similar goods produced abroad (Liman & Adamu 2015). Upgrading the locally produced goods will eventually lead to creation of more market thereby discouraging the purchase of similar goods produced abroad. In casting, the part being produced and the tooling used to produce the part interact in complex ways, which affect the safety of casting professionals, quality and cost of the casting. Hence, the need to investigate the techniques for standardizing mould preparation practices in local metal casting operations in Kano State, Nigeria.

Purpose of the Study

The study investigated techniques for standardizing mould preparation practices in local metal casting operations in Kano State, Nigeria. Specifically, the study :

1. Determine techniques for standardizing mould preparation practices in local casting operations in Kano state, Nigeria.
2. Identify techniques for standardizing safety precautions to be observed in mould preparation practices in local casting operations in Kano state, Nigeria.

Research Questions

The following research questions we answered in this study:

1. What are the techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria?
2. What are the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State, Nigeria?

Hypotheses

The following null hypotheses were formulated and were tested at 0.05 level of significance:

HO_1: There is no significant difference in the mean responses of metal casting artisans, metal work industrial personnel and metalwork lecturers on the techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria.

HO_2: There is no significant difference in the mean responses of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State, Nigeria.

Research Methodology

This study investigated techniques for standardizing mould preparation practices in local metal casting operations in Kano State, Nigeria. Two research questions guided this study and two hypotheses were tested at 0.05 level of significance. The study adopted descriptive survey research design. The population for the study was 1551 respondents, comprising of 1500 Foundry artisans, 35 Metalwork Technology Industrial Personnel and 16 Metalwork Technology Lecturers respectively in Kano State, Nigeria. Out of the 1500 artisans, 316 was sampled using Taro Yamane formula, Therefore a total of 367 respondents were used for the study. Out of the 367 questionnaire administered, only 351 was returned making a percentage instrument return rate of 95 percent. The instrument for data collection was 36 items questionnaire. Three lecturers from Federal University of Technology, Minna validated questionnaire. Cronbach's Alpha reliability was employed for checking reliability and the index was found to be 0.92. Mean and Standard deviation was use to answer the research questions while one way Analysis of Variance (ANOVA) was use to test the null hypotheses at 0.05 level of significance.

The decision rule for the research questions were based on the resulting mean scores interpreted relative to the concept of real lower and upper limits of numbers shown in Table 1 while the decision rule for the null hypotheses were based on comparing the significant value with (P<0.05) level of significant, that is where the significant value is less than (P<0.05) it were rejected, while equal or greater than the (P<0.05) level of significant the null hypotheses were upheld and accepted.

Table 1:Decision Rule for Research Question

S/NO	Response Mode	Rate	Real Limit	Decision
1.	Strongly Agree	4	3.50 – 4.00	Strongly Agree
2.	Agree	3	2.50 – 3.49	Agree
3.	Disagree	2	1.50 – 2.49	Disagree
4.	Strongly Disagree	1	1.00- 1.49	Strongly Disagree

Results

Research Question One: What are the techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria?

Table 2: Mean and Standard Deviation of Metal Casting Artisans, Metalwork Industrial Personnel and Metalwork Lecturers on Techniques for Standardizing Mould Preparation Practices in Casting Operation.

N=351

S/N	ITEM	$\bar{x}_1$ n=300	$\bar{x}_2$ n=35	$\bar{x}_3$ n=16	$\bar{x}_A$	SD_A	D

1	Use digital electronics sand testing equipment for testing sand quality	3.35	3.31	3.63	3.43	0.56	A
2	Use of Computer Aided Design (CAD) software to produce drawings of pattern.	3.35	3.49	3.06	3.30	0.60	A
3	Use of casting process simulation software to simulate or give quantitative prediction of the mechanical properties of cast component	3.34	3.46	3.50	3.43	0.54	A
4	Identification of shrinkage allowance on pattern	3.35	3.51	3.13	3.33	0.61	A
5	Interpretation of shrinkage allowance on pattern	3.16	3.17	3.06	3.13	0.68	A
6	Practical knowledge in the application of melting temperature for different metals	3.47	3.49	3.56	3.51	0.52	SA
7	Skills in reading and interpreting digital temperature measuring instrument	3.24	3.20	3.25	3.23	0.90	A
8	Practical knowledge in applying tolerance limit on pattern and core	3.48	3.49	3.56	3.51	0.52	SA
9	Reading and interpretation of working drawings of target casting products	3.33	3.29	3.63	3.42	0.56	A
10	Practical understanding in the application of geometry of shapes and design requirements	3.35	3.40	3.50	3.42	0.56	A
11	Understanding of different types of furnace in terms of requirement for usage	3.34	3.31	3.56	3.40	0.57	A
12	Application of different types of metallic properties and application in casting operation	3.36	3.46	3.25	3.36	0.60	A
13	Practical understanding of sand properties and their application in sand moulding	3.16	3.17	3.06	3.13	0.68	A
14	Use of electronic power driven cleaning and finishing equipment for removing unwanted cast parts	3.47	3.49	3.56	3.51	0.52	SA
15	Use of electrically powered moulding sand compaction equipment	3.24	3.20	3.25	3.23	0.90	A
16	Application of the bonding properties of green sand used in green sand moulding	3.48	3.49	3.56	3.51	0.52	SA
17	Use of Computer Aided system to define the dimensional parameters of the proposed cast product	3.33	3.29	3.63	3.42	0.56	A
18	Exposure of foundry workers to computer aided design software to modify geometrical shapes to increase production quality	3.35	3.40	3.50	3.42	0.56	A
19	Using computer aided design software to produce foundry model	3.34	3.31	3.56	3.40	0.57	A
	GRAND MEAN	**3.34**	**3.36**	**3.41**	**3.37**		**A**

Key: D = Decision, SD_A= Standard Deviation, $\bar{x}_{1=}$ Mean of Metal Casting Artisans (MCA), $\bar{x}_{2=}$ Mean of Metalwork Industrial Personnel (MIP), $\bar{x}_{3=}$ Mean of Metalwork. Lecturers (ML), SA= Strongly Agree, A= Agree, D=Disagree ,SD= Strongly Disagree.

Result in Table 2 shows the views of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria. The respondents strongly agreed to items 6, 8,14 and 16 with mean value of 3.51 each. In their responses, the respondents agreed to items 1,23,4,5,7, 9,10,11,12,13,15,17 and 18 with mean score ranging from 3.13 – 3.43. The grand mean of metal casting artisans, metalwork industrial personnel and metalwork lecturers are respectively 3.34, 3,36 and 3.41 indicating that the respondents agreed to the techniques presented for standardizing mould preparation practices in casting operation in Kano State. Also the grand mean for total respondents which is 3.37 signified that the three groups of respondents agreed to the items as techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria. The standard deviation of the items ranges from 0.52 - 0.90. The 19 items had their standard deviation less than 1.96 showing that the respondents were not too far from the mean and were close to one another in their responses.

Research Question Two

What are the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano state, Nigeria?

Table 3: Mean and Standard Deviation of Metal Casting Artisans, Metalwork Industrial Personnel and Metalwork Lecturers on techniques for standardizing safety precautions in mould preparation practices in casting operation. N=351

S/N	ITEM	$\bar{x}_1$ n=300	$\bar{x}_2$ n=35	$\bar{x}_3$ n=16	$\bar{x}_A$	SD_A	D
1	Providing adequate ventilation to reduce hazards from mixture of moulding sand, water and binding materials	3.33	3.17	3.31	3.27	0.66	A
2	Using noise pads to dampen noise or reduce the impact of noise arising from moulding operation	3.32	3.29	3.31	3.31	0.59	A
3	Applying proper sanitary practices (good personal hygiene) during moulding operation to prevent slips and falls	3.34	3.31	3.25	3.30	0.64	A
4	Use of protective clothing and equipment during mouldpreparation	3.35	3.31	3.31	3.32	0.55	A
5	Making provision for dealing with emergency that may arise during mouldprepartion activity	3.15	3.14	3.25	3.18	0.66	A
6	Properly labelingof all hazardous substances use for moulding	3.50	3.51	3.44	3.48	0.51	A
7	Training foundry workers to inform them of possible foundry hazards associated with mould preparation operation	3.25	3.23	3.19	3.22	0.90	A
8	Training foundry artisans on how to control hazards during mouldpreparation	3.50	3.51	3.44	3.48	0.51	A
9	Providing regular inspection of workers at each stage of mouldpreparation	3.34	3.23	3.19	3.25	0.66	A
10	Adhering strictly to safe operating procedures during mould creation operation	3.34	3.23	3.25	3.27	0.65	A
11	Regularly checking mouldingequipment to ensure they are in safe operating condition	3.34	3.17	3.38	3.30	0.63	A
12	Keeping records of moulding maintenance practices	3.32	3.34	3.19	3.28	0.62	A
13	Using simple mechanized machines to do strenuous tasks during moulding operation	3.15	3.14	3.25	3.18	0.66	A
14	Using air purifying respirators to reduce risk of inhalation of hazardous dust from mould sand	3.50	3.51	3.44	3.48	0.51	A
15	Regularly reporting status about damaged equipment in hazardous condition	3.25	3.23	3.19	3.22	0.90	A
16	Maintaining regular practices of house keeping	3.50	3.51	3.44	3.48	0.51	A
17	Keep regular use of safety devices	3.34	3.23	3.19	3.25	0.66	A
	GRAND MEAN	**3.34**	**3.30**	**3.30**	**3.31**	**0.64**	**A**

Table 3 shows the opinions of the metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano state, Nigeria. The three categories of respondents unanimously agreed to all the items with mean value ranging from 318 - 3.48. This implies that the items presented are techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano state, Nigeria. The grand mean of metal casting artisans, metalwork industrial personnel and metalwork lecturers are respectively 3.34, 3.30 and 3.30 indicating that the respondents unanimously agreed to the techniques presented for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano state, Nigeria. Also the grand mean for total respondents which is 3.31 signified that the three groups of respondents agreed to the items as techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State. Table 3 also showed that the standard deviation of the items ranges from 0.51 - 0.90. The 17 items had their standard deviation less than 1.96 showing that the respondents were not too far from the mean and were close to one another in their responses.

Hypotheses Testing

Hypothesis One

There is no significant difference in the mean responses of metal casting artisans, metal work industrial personnel and metalwork lecturers on the techniques for standardizing mould preparation practices in casting operation in Kano state, Nigeria.

Table 4 : One-way ANOVA of mean scores of respondents on the techniques for standardizing mould preparation practices in casting operation

Source	Sum of Square	df	Mean Square	F	Sig. (p-value)
Between Groups	0.088	2	0.044	1.699	0.184
Within Groups	8.975	349	0.026		
Total	9.063	351			

The result of analysis as presented in Table 4 showed that there was no significant difference ($p > 0.05$) in the mean scores of the respondents. The hypothesis one was therefore upheld (accepted). The data supported the hypothesis one, $F(2, 349) = 1.699$, p (sig.) $= 0.184$. This result implies that the items presented are suitable techniques for standardizing mould preparation practices in casting operation in Kano State.

Hypothesis Two

There is no significant difference in the mean ratings of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano state, Nigeria.

Table 5 : One-way ANOVA of mean scores of respondents on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation

Source	Sum of Square	df	Mean Square	F	Sig. (p-value)
Between Groups	0.084	2	0.042	1.937	0.146
Within Groups	7.537	349	0.022		
Total	7.621	351			

The result of analysis as presented in Table 5 showed that there was no significant difference ($p > 0.05$) in the mean scores of the respondents. The hypothesis two was therefore upheld (accepted). The data supported the hypothesis two, $F(2, 349) = 1.927$, p (sig.) $= 0.146$. This result implies that the items presented are suitable techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State.

Findings of the Study

With respect to the research questions and hypotheses of this study the summary of the findings of this study among others are given below:

1. The techniques for standardizing mould preparation practices in casting operation are use of Computer Aided Design (software) in pattern construction, use of simulation software to predict properties of cast product, use of electronic digital moulding equipment, identification and interpretation of shrinkage allowance on pattern as well as application of the practical knowledge of sand properties during sand moulding.
2. The techniques for standardizing safety precautions in mould preparation practices in casting operation are : adhering strictly to safe operating procedures during mould preparation activity, regularly inspecting foundry workers at each stage of mould preparation, using the appropriate mould preparation tool for specific task, regularly checking to ensure moulding equipment are in safe working condition, keeping records of moulding equipment maintenance as well providing adequate ventilation to reduce hazards resulting from mixture of mould sand and binding materials, among others.
3. There is no significant difference in the mean responses of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria.
4. There is no significant difference in the mean responses of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State, Nigeria.

Discussion of Findings

Findings on the techniques for standardizing mould preparation practices in casting operation in Kano State revealed among others that , the techniques for standardizing mould preparation practices in casting operation are use of Computer Aided Design (software) in pattern construction, use of simulation software to predict properties of cast product, use of electronic digital moulding equipment, identification and interpretation of shrinkage allowance on pattern as well as application of the practical knowledge of sand properties during sand moulding.

These findings are in consonance with findings of Meehanite (2015) who in his study on casting design as influenced by foundry practice reiterated the immense significant role played by Computer Aided Design (CAD) software in accuracy in pattern construction. Meehanite (2015) also discovered that the use of CAD software enhances higher precision in pattern design and thus enhances the quality and shape of mould produce in foundries.

The findings on the use of simulation software to predict properties of cast product was supported by Panchal (2010) who in a study on foundry practices in Indian, found out that simulation process have greatly helped in identification of possible defects in mould preparation. This simulation process according to Panchal (2010) has immensely reduced mould production cost in Indian foundry industries.

The findings on the use of electronic digital moulding equipment was also buttressed by Basharu (2009) who in a study of skill improvement needs of foundry technology teachers discovered that metalwork teachers as well as practicing artisans and craftsmen in Nigeria mostly use outdated mould equipment that consumes more time in mould preparation as well as reduces accuracy of moulds produced. Basharu (2009) lamented that the local mould equipment reduces the quality of moulds produced and called for the need for metalwork teachers as well as practicing artisans and craftsmen in Nigeria to adopt the use of electronic digital moulding equipment to enhance their speed and accuracy of mould preparation.

The findings on hypothesis one revealed that, there is no significant difference in the mean responses of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing mould preparation practices in casting operation in Kano State, Nigeria. The hypothesis was therefore upheld (accepted). This result implies that the items presented are suitable techniques for standardizing mould preparation practices in casting operation in Kano State. The similarities in their opinion could likely be due to the current prevailing dominance of the use of computer and computer software in metal casting activities in modern foundries.

Findings on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State revealed among others that, techniques for standardizing safety precautions in mould preparation practices in casting operation are : adhering strictly to safe operating procedures during mould preparation activity, regularly inspecting foundry workers at each stage of mould preparation, using the appropriate mould preparation tool for specific task, regularly checking to ensure moulding equipment are in safe working condition, keeping records of moulding equipment maintenance as well providing adequate ventilation to reduce hazards resulting from mixture of mould sand and binding materials, among others.

The findings on adhering strictly to safe operating procedures during mould preparation activity is in line with the findings of Anshika (2017) who studied top ten foundry safety practices and discovered that a key parameter for high yield and safe operation is to strictly adhere to existing standard work procedure established to ensure safety precaution is improved in foundries.

The findings on regularly inspecting foundry workers at each stage of mould preparation, using the appropriate mould preparation tool for specific task, regularly checking to ensure moulding equipment are in safe working condition is in agreement with the research discoveries of National Institute for Occupational Safety and Health (NIOSH, 2015) who in a study on the control of occupational safety and health hazards in foundries found that to enhance safety precaution in mould preparation, engineering controls such as local exhaust ventilation, noise damping materials, machine guarding, molten metal splash barriers, and radiant heat shielding can be employed to provide a healthful and safe working environment for mould preparation in foundries.

The findings on hypothesis two revealed that, there is no significant difference in the mean responses of metal casting artisans, metalwork industrial personnel and metalwork lecturers on the techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State, Nigeria. The hypothesis two was therefore upheld (accepted). This result implies that the items presented are suitable techniques for standardizing safety precautions to be observed in mould preparation practices in casting operation in Kano State.

Conclusion

From the findings of this study, it can be concluded that techniques for standardizing mould preparation practices in local metal casting operations in Kano State, Nigeria were established. The techniques are in the area of mould

preparation as well as safety precautions in mould preparation practices. The study has provided an additional literature to the existing body of knowledge in the techniques for standardizing mould preparation practices in local metal casting operations in Kano State, Nigeria. This provides an empirical evidence for the use of the different techniques for standardization in mould preparation as well as in enhancing safety precaution in mould preparation practices.

Recommendations

Based on the findings from this study, the following recommendations are made :

1. Foundry artisans should endeavor to adhere strictly to the techniques that are used for standardization and enhancing safety in mould preparation in metal casting practices.
2. Kano State Government through the appropriate authority should create awareness of the various techniques that are used for standardization in mould preparation and encourage the stakeholders to adhere strictly to these techniques to enhance quality and safe work practice in mould preparation operations to improve metal casting practices in Kano State, Nigeria.
3. Kano State Government should make effort to purchase the modern computer and electronic equipment that can be use to enhance standard operational practices in mould preparation practices in metal casting. Constant power supply to enable the stakeholders reduces their cost on using generators for their operations are also needed.
4. Quality training and periodic retraining programmes should be organize for foundry artisans and other foundry practitioners to expose them on how to use modern electronic foundry equipment to enhance standardization in mould preparation practices.
5. Industries, government, non-governmental agencies, private enterprises and communities should provide consumable materials necessary for practical activities and teaching techniques for standardizing safety precautions to be observed in mould preparation practices in metal casting practices in Kano State, Nigeria.

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