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ASSESSMENT OF AUTOMOBILE ENGINES REBUILT AT LOCAL ARTISAN WORKSHOPS IN GHANA

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ABSTRACT
The manufacturing industry of Ghana, as promising as it is, has many shaping to be done. This specifically goes to the automobile manufacturers and engine rebuilders of Ghana. Though agile and very skillful in rebuilding engines many have reported grievances on their service renders to them. This shows that, the knowledge and zeal to rebuild it puts the industry at a certain level but needs further additional and requisite tuning to reach the pinnacle. For this reason, the research therefore sought to investigate how cylinder bores and piston ring end-gap contribute to the failure of locally rebuilt engines. A descriptive design was used for the study and sample of 60 participants responded to the structured questionnaire. The study used primary data to provide reliable and up-to-date information the researcher needs for the analysis. The data were entered in SPSS with analysis performed using inferential and descriptive analysis methods. The findings of the study revealed that errors made in the work procedure had a stronger effect on the clients' than its other counterpart. Practically, the flaws in the work procedure of rebuilding cylinder bore significantly affects clients' satisfaction.
Keywords: *Engine Rebuilt, Local Artisans, Cylinder Re-bore, Piston Ring, Automobile.*

1. Introduction

The importation of used machinery and parts, especially automobile engines are very common in Ghana. In automobiles, large deposits of used parts are seen in spare parts shops in most parts of the country. Suame in Kumasi, Abosey Okai and Kokompe in Accra are major locations where imported used automobile parts are deposited for sale on arrival into the country (Mensah and Adu, 2015). It can be said that the interest in pre-owned automobile parts, especially engines, has been enormous over the past few decades.

These home-used engines are presumed to last longer than the rebuilt engines. The usual practice is the sale of the used engines as it is basis, with no warranties or customer satisfaction guarantees. Sometimes, one could be lucky to get a short period guarantee, three to seven days warranty. These assurances in most cases do not work and when there is an actual problem with the usage or the component cannot work after the agreed warranty period, a customer might end up not getting his or her investment back. For example, an engine that is sold from any of the stated locations can only be tested by starting for some few seconds (for manually injected diesel engines) prior to purchase or on the chassis after installation. These tests are usually physical observation for leakages and idling response and leak-down test from the positive crankcase ventilation (PCV) valve (Shafie, 2016). The sellers used no standard or technical procedures in testing these products for quality. The efficiency of used engines depends on a good maintenance culture. Some of these imported engines may be uninstalled from scrapped engines or vehicles involved in accidents and may have undetected problems.

Frequently, fixed engines are principal to even modern car engines because stronger parts are employed, or lie out variations in parts altered complications with the initial engine (Pravin et al., 2020). This widening movement of preferring for home-employed engines suggests the expanding disparity that is being generated by the omission of engine overhaul. Ghana cannot boast of measurable local workshops where one can drive in and be assured of an efficient engine rebuild, with warranty or properly documented customer satisfaction guarantees. Such services are available with the big automobile giants like Toyota, Japan Motors, Mechanical Lloyd etc, which are limited to their respective brands (Khan et al., 2019). The Artisans largely did overhaul

and rebuilding of automobile engines in Ghana in the various mechanic workshops within the country. Though it is affordable, there are various problems faced by customers who seek these local artisans to overhaul and rebuild their automobile engines. Some problems being faced are that the engine would not last long, breaks down early or does not work at all because of the lack of adherence to standard re-manufacturing processes and specifications (Fitch, 2012).

In view of this, the research seeks to investigate the manufacturing specifications regarding the cylinder bore geometry, used by these artisans to rebuild automobile engines in some of the cylinder re-boring and mechanic workshops within the country (Wahab et al., 2018). If rebuilding of engines can be done right, it has the potential to stimulate industrial growth and to satisfy the general desire for quality interchangeable parts in the country. End users of automobile engines would be delighted to spend more for quality goods and services, than to spend on goods and services whose reliability cannot be guaranteed. The abrupt failure of engines rebuilt by local artisans is a primary aim which this thesis seeks to unravel. The main aim of this research is to investigate how cylinder bores and piston ring end-gap contribute to the failure of locally rebuilt engines. This was done by determining local artisan theoretical knowledge of remanufacturing specifications, and examining the procedures artisans use for engine rebuilt.

The significance of internal combustion engines in transportation cannot be underrated in Ghana and the world at large. Literature is currently limited regarding failure of automobile engines in Ghana. This study will therefore be an addition to literature and contribute in affecting knowledge, and also aid stakeholders to come out with good policies for artisans in our local automobile industries. The findings of this research should aid policy makers in coming out with frameworks and syllabi in required institutions, and further accommodate all local artisans who are interested in gaining much knowledge in automobile engine rebuild. It should also boost the confidence of our local artisans regarding engine rebuild, which will go a long way to enhance their skill. The study could also be useful to importers of pre-owned engines to authenticate the durability of engines they import into the country. Thus, the importers can make use of the findings as a standard purchase procedure to ascertain the history of every engine they opt to buy, in order to achieve customer satisfaction. Lastly, the findings could inform those who patronize pre-owned engines to examine their purchases with respect to their respective historical data.

2. Methodology

Given the current research objectives and learning problem and theories, this study focused on the construction of descriptive research. Descriptive design was used because researchers wanted to describe and document the features of the situation as they occur naturally and report the current state of the incident. By doing so, one increases the chances of collecting data that adequately meets the research objectives. The choice of descriptive design helps to define the features of the large number. Also, the design allows for the use of a variety of data collection methods such as questionnaires and interview methods and the use of common questions where the reliability of objects can be determined (Mai et al., 2018).

The study looked at accessible data and a sampling frame gathered from this data to reinforce the design. Questionnaire was constructed and executed to the respondents. To implement this method rational with the mixed technique, the study raises the material in a manner to control the exercise variables with distinct based designs and scale.

The target population for this study is local artisans (auto mechanics) all over the country. This is limited to cylinder boring machine shops within the Accra metropolis. Major locations where local artisans request for services of cylinder machining are Abbosey Okai, Odornaa and Kokompepe, and research has shown that these locations have two, six and three cylinders to block machining shops, respectively. Because of the complexity of the research, it was highly imperative that only experienced machinists were selected for this study in order to yield reliable answers to pertinent questions.

The study appropriately used purposive sampling technique, which involves machinists who would provide the needed data for this research. Regarding the sample size of this study, sixty (60) technicians were purposely selected from the respective machine shops for this study as representatives. In view of the sample size, the researchers made it a point to select respondents based on their experiences on the job to partake in the study.

The study used primary data for the analysis because; there were no readily available secondary data for the study. Second, primary data is the only source of data that would provide reliable and up-to-date information the researcher needs for the analysis.

2.1. Data Collection

The structured questionnaire was employed as the data collection instrument in this study. The data collection technique adopted for the study was closed and opened ended questionnaires. Interviews can be structured, unstructured, or semi-structured (Wulfmeyer et al., 2018). This research followed semi-structures, which explored a list of open and closed-ended questions with the respondents. This technique not only gives respondents time to articulate themselves but also allows the researcher to ask probing and leading questions for a deeper understanding about the subject investigation.

The questionnaire was categorized into four (4) parts thus, Part A, Part B, Part C and Part D. Part A provides the demographic data of the respondents while Part B tests the theoretical knowledge of the respondents regarding re-manufacturing specification on cylinder bores. Part C goes further to bring out the inputs on how they prepare the cylinder bore. Part D deals with questions pertaining to specifications machinists receive from mechanics who patronize their services.

Semi-structured questionnaire was chosen because it supports the research approach and also the design. It also enhances the choice of answers from the respondents. It can provide close- and open-ended questions which could measure variables quantitatively.

2.1. Instrument Reliability

Reliability refers to the consistency of raw score received by the same people when they are re-tested with the same tests at different times, or with different sets of the same items, or under other dynamic test conditions. Reliability demonstrates accuracy, precision, and consistency of measurements (Hair Jr et al., 2017). Reliability is stability of the measure of variables or research instruments. The study adopted the Cronbach alpha.

The efficient use of Cronbach alpha (Flynn et al., 2018) often tests the internal consistency of the measurement variables. According to (Tobi and Kampen, 2018), Cronbach alpha is reliable if the variable is 0.6 and above. The variables were tested, and they were all above the thresholds recommended by (Hair Jr et al., 2017).

3. Results and Discussions

3.1. Demographic Data

Results from the study revealed that all the respondents were males. This shows that the selected participants engaged at the time the study was conducted were all males. This may be attributed to the affirmative action program taken by the government. About 13% of the respondents were 24 years and below, 28% of them, were between 25-40 years, 46.7% were between 41-55 years while 12% were above 55 years. This shows that most of the participants were within the ages of 25 to 55 years and the least age participants were above 55 years. This is seen in Fig.1.

Findings from the study revealed that, 51.7% of the respondents were junior high school (JHS) levers, 25.8% were senior high school (SHS) levers while 22.5% were up to tertiary level. This shows that most of the participants were within JHS level. This can be seen in Fig. 2. From Fig. 3, the respondents had been working in their shops for less than 5 years representing (11.7%); this is followed by those with 10 to 20 years of experience (70%) and more than 20 years of experience (18.3%) respectively. This shows that most of the participants within 10-20 years had the highest experiences and participants with less than 5 years had least experience.

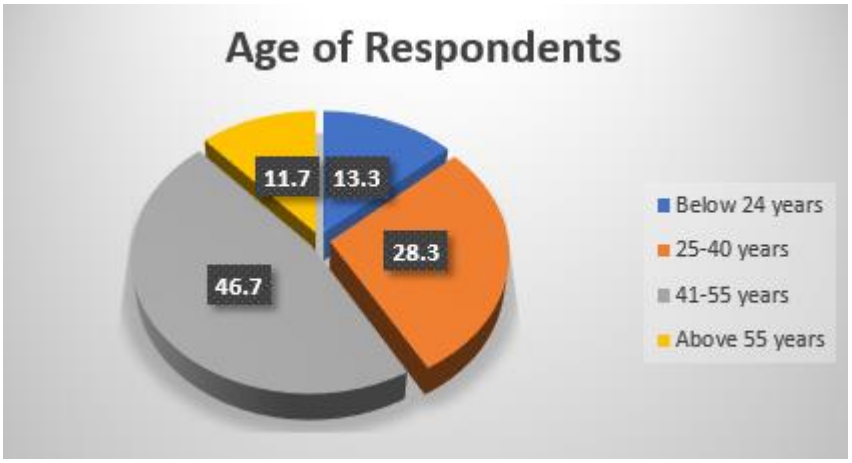

Fig. 1. Age of Respondents

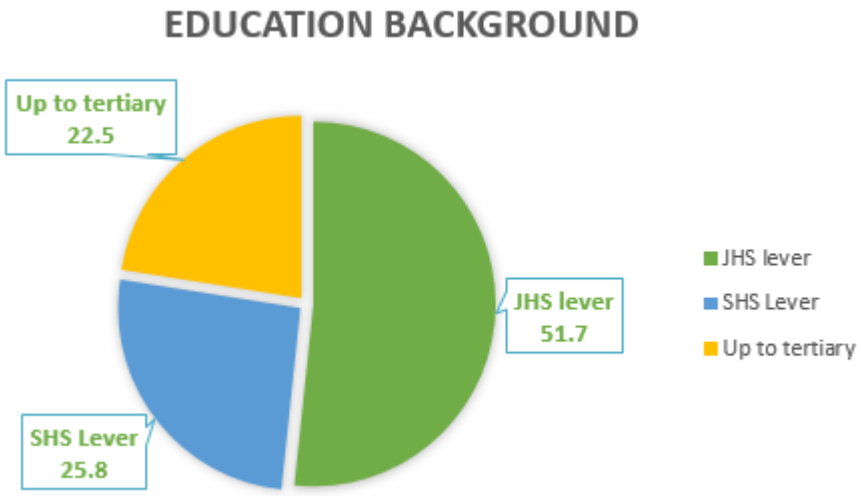

Fig. 2. Educational background

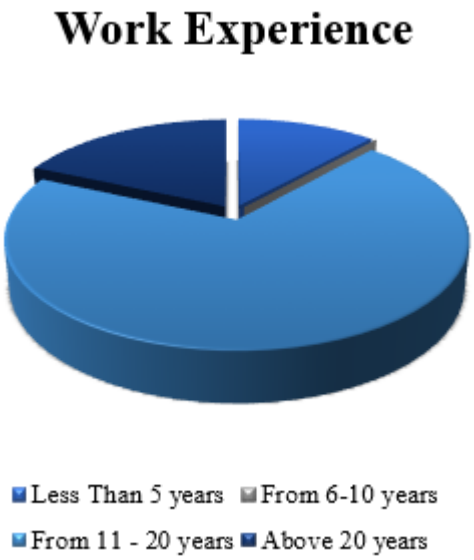

Fig. 3. Work Experience

3.2 Theoretical Knowledge of Local Artisans

The first objective of the research was to determine whether local artisans are theoretically knowledge oriented about cylinder bore re-manufacturing specifications using descriptive statistical-frequency and percentages. The following are the responses from the participants;

When asked about the frequency of participant knowledge regarding coming across specifications for rebuilding engines, it was revealed that 16% of the participants responded as "Not at all". 42% responded "A little", 11% responded "Moderately", 26% responded "Mostly" while 5 % of the respondents said they have come across specifications for rebuilding engines (see Fig. 4.).

From the results, it was deduced that most workers operating at Kokompe, Abossey Okai and Odornaa in Accra do not have specification knowledge for rebuilding engines. This indicates why there is always abrupt failure of engines rebuilt by local artisans. Engine rebuild involves removing the engine from the vehicle and completely disassembling it from what is popularly referred to as carb to pan (Tim Charlet, 2015). However, most of the local artisans do not have knowledge hence leading to poor engines rebuilt by local artisans.

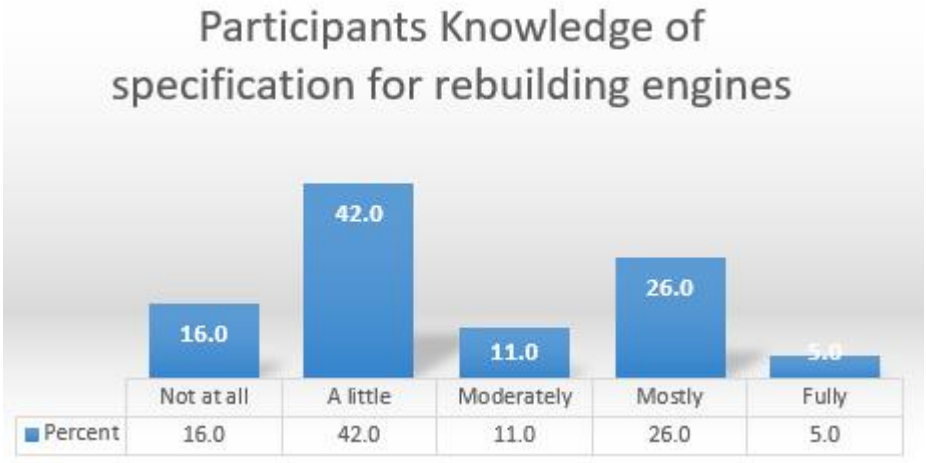

Fig. 4. Field Survey, 2021

When participants were asked regarding knowledge of Engine Cylinder Bore-Re-Manufacturing, it was revealed that 21% of the respondents said they do not have any knowledge of engine cylinder bore-re-manufacturing, 53% said that they have little knowledge, 16% said they have moderate knowledge, while 11% said they have most knowledge of engine cylinder Bore-Re-Manufacturing (see Fig. 5).

From the results, it was deduced that half of the local artisans operating at Kokompe, Abossey Okai and Odornaa in Accra have little knowledge of Engine Cylinder Bore-Re-Manufacturing. The finishing of cylinder bores is very critical to the durability of a rebuilt engine. Precision finish boring is a critical process for machining an accurate cylinder for engine block (Chen, 2017; Liu, 2021).

According to Carley, (2019), using the cylinder bore in the engine block is important for the engine power, oil consumption, and piston ring friction. The geometry of the cylinder bore should be as round as possible with little or no taper or variation vertically. Proper sealing of the combustion chamber can be obtained by using manufacturer's specification.

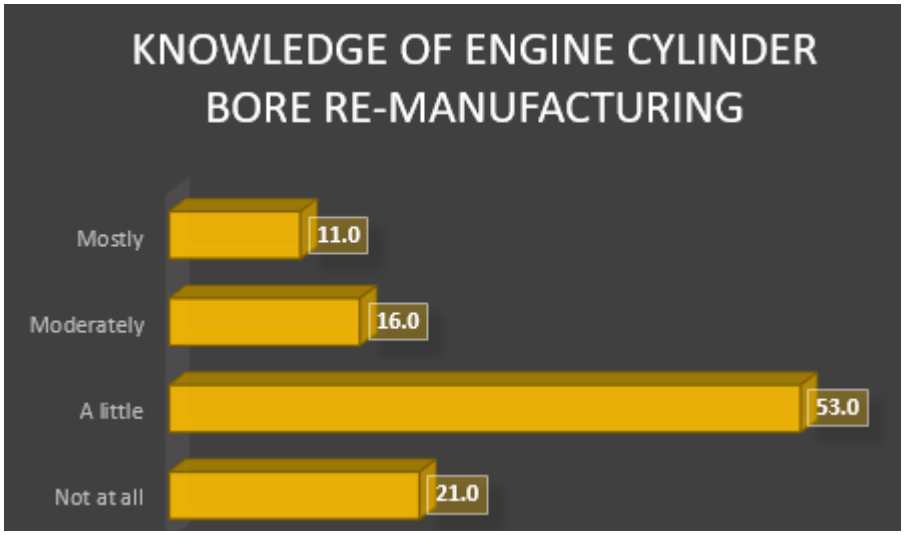

Fig. 5. Knowledge of engine cylinder bore remanufacturing

Similarly, participants were asked concerning Knowledge of Original Equipment Manufacture's (OEM) specifications regarding cylinder bore re-manufacture. It was exposed that 42% have no knowledge of OEM specifications, 42% have little knowledge, 11% have moderately knowledge and respondents representing 5% have enough knowledge (See Fig. 6).

From the results, it was revealed that almost 42% of the local artisans operating at Kokompe, Abossey Okai and Odornaa in Accra have little or no knowledge of OEM specifications regarding cylinder bore re-manufacture. Little knowledge among Ghanaian artisans have caused most of the rebuilt engine not to last longer than customers' expectations.

This is affirmed by (Huizenga, 2018) who claimed that ring gap is absolutely critical to engine performance and longevity, setting the correct ring gap on aftermarket piston rings is crucial for proper performance and engine longevity. Besides, a large gap at the end of the ring allows for an easier leak path and can directly bleed off the precious cylinder pressure that is so difficult to achieve (Smith, 2019; Thomas, 2019).

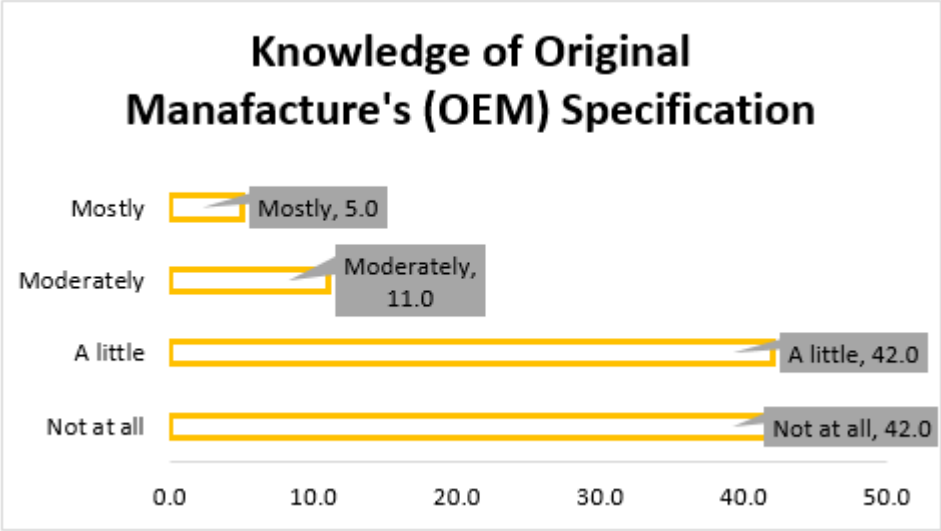

Fig. 6. Knowledge of OEM specifications for bore re-manufacture

The participants were asked whether they have knowledge of periodically calibrated measurement instruments. It was revealed that 11% had no knowledge at all, 21% have little knowledge, 5% responded as having moderate knowledge of periodically calibrated measurement instrument, 58% responded having enough knowledge, whereas 5% of respondents were fully knowledgeable of periodically calibrated measurement instrument (See Fig. 7). The results suggest that almost more than half of the local artisans have knowledge of periodically calibrated

measurement instruments which is remarkable. However, this is not enough to bring out better performance for customer satisfactions as far as re- build engine is concerned. Local Artisans should have knowledge about manufacturing specification in detail, be aware that there are Original Equipment Manufacture's (OEM) specifications regarding cylinder bore re-manufacture, an idea about engine cylinder bore re-manufacturing specifications, and more so rebuilding engines to meet clients' taste.

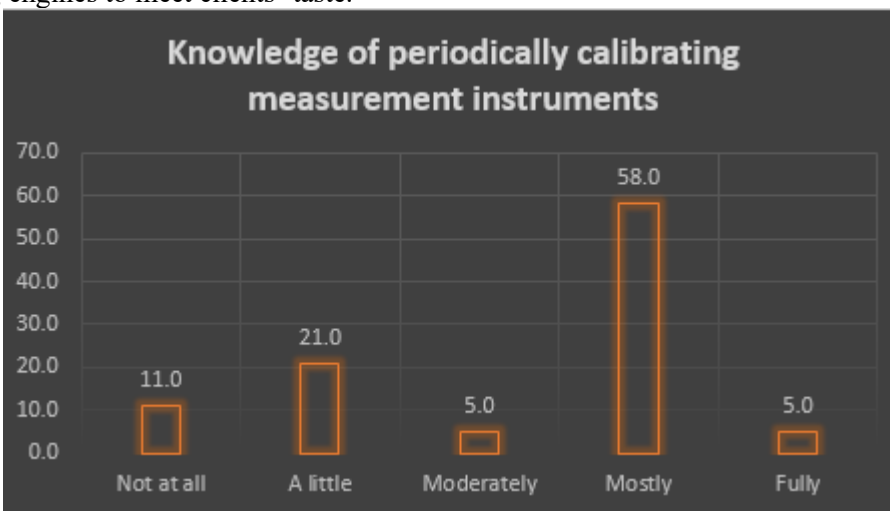

Fig. 7. Knowledge of periodically calibrated measurement instrument

The study further determined whether local artisans are theoretically knowledge oriented about cylinder bore re-manufacturing specifications using descriptive statistics-mean to rank the knowledge in order of importance. Table 1 indicates the descriptive statistics for determining whether local artisans are theoretically knowledge oriented about cylinder bore re-manufacturing specifications.

Table 1- Descriptive statistics for determining whether local artisans are theoretically knowledge oriented about cylinder bore re-manufacturing specifications.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Have you come across specification for rebuilding engines	120	1.00	5.00	2.3667	1.05267
Do you have an idea about engine cylinder bore re-manufacturing specifications	120	1.00	4.00	2.6083	0.93751
Do you know there are manufacture specific detailed measurement limits for engine rebuild regarding cylinder bores	120	1.00	4.00	2.0667	0.73030
Are you aware there are Original Equipment Manufacture's (OEM) specifications regarding cylinder bore re-manufacture	120	1.00	4.00	1.7417	0.79384
Do you know measurement instruments are calibrated periodically to ensure their accuracy	120	1.00	5.00	3.1667	1.14005
Do you know a successful engine rebuild requires absolute adherence to re-manufacturing specifications	120	1.00	3.00	1.6333	0.62083
Do you know cylinder bore/sleeve geometry and surface finish must meet Original Equipment Manufacture's (OEM) specification after machining	120	1.00	3.00	1.5667	0.67030
Valid N (leastwise)	120				

From the results, majority of the local artisans do not have knowledge on how measurement instruments are calibrated periodically to ensure accuracy. This has affected the better outcome of engine rebuild. The geometrical accuracy of cylinders is defined by cylindricity, which is critical to the product performance. Using the cylinder bore in engine block as an example, cylindricity is important for the engine power, oil consumption, and piston ring friction. The geometry of the cylinder bore should be as round as possible, with little or no taper or variation vertically (Carley, 2012).

One of the key factors related to the demand for a durable engine in transportation is the need to limit thermo mechanical internal losses, wear, and lubricating oil consumption, which are conditioned by the tribological behavior of the piston–cylinder assembly (Woś and Mikalski, 2011). The surface modification of engine cylinder bores with improved sliding properties is often produced by the honing process. This multi-stage process is performed using abrasive stones loaded against the bore with simultaneous rotation and oscillation. To guarantee this process, robustness with acceptable dimensional accuracy and surface quality, the stone dynamic effects in continuous balanced contact with the workpiece have to be studied deeply (Mansori et al, 2013). A good surface finish enables quick engine break-in procedure, good oil lubrication of the pistons and rings and also complete seal of the combustion chamber.

Cylinder liner surface finish controls the frictional losses, oil consumption, and emissions of internal combustion engines to a large extent. In order to minimize such losses, it is imperative to improve the liner surface texture by a consistent and more productive finishing process (Dimkovski *et al,* 2012).

3.3 Adherence of local artisans to OEM cylinder bore specifications

The second objective of this study was to examine how local artisans adhere to OEM/Manufacturer cylinder bore specifications using descriptive statistic-mean to analyze the data. Table 2 present the descriptive statistics for examine how local artisans adhere to OEM/Manufacturer cylinder bore specifications

Table 2 - Descriptive Statistics for examine how local artisans adhere to OEM/Manufacturer cylinder bore specifications

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Do you use Original Equipment Manufacture's (OEM) specifications for piston to bore clearance	19	1.00	3.00	1.5500	0.83867
Do you use OEM specifications for taper in cylinder bore	19	1.00	3.00	1.6083	0.75921
Do you adhere to Original Equipment Manufacture's (OEM) piston ring and gap specification	19	1.00	3.00	1.9167	0.68087
Do you compare the cylinder out-of-roundness to Original Equipment Manufacture's (OEM) specification	19	1.00	3.00	1.7583	0.64815
Do your cylinder/surface finish conforms to Original Equipment Manufacture's (OEM) cross hatch surface finish	19	1.00	4.00	2.0083	0.82499
Total					

According to Huizenga (2018), ring gap is absolutely critical to engine performance and longevity, setting the correct ring gap on aftermarket piston rings is crucial for proper performance and engine longevity. Piston rings are split in geometry to allow easy installation on the piston grooves. Before installation on the piston grooves, the split ends must be gapped with respect to

OEM specifications and engine application. Large gap at the end of the ring allows for an easier leak path and can directly bleed off the precious cylinder pressure that is so difficult to achieve (Smith, 2019).

The performance of piston rings is very important for internal combustion engines and can be accurately predicted by the accuracy of it's out of roundness by engine designers (Sherrington *et al,* 1995). The lighter the block, the more vulnerable it is to this type of bore distortion (Carley, 2012). If the block is bored and honed without the simulated load created by a torque plate, the bore may be perfectly round after it has been machined, but it won't stay that way. Excessive cylinder bore out-of-roundness (OOR) can adversely affect the sealing functionality and durability of the piston-ring pack in an engine (Blossfeld *et al,* 1993).

Therefore, it is imperative that our local artisans adhere to strict remanufacturing specifications.

According to Carley, (2012), too much cylinder bore taper is bad because it causes the rings to flex in and out as the piston slides up and down. Excessive taper can lead to ring breakage as well as interference problems if the ring end gap is not sufficient to handle the change in bore diameter. With gapless rings, good bore geometry and taper are even more important to minimize blow by and compression loses and to maximize the benefits provided by this style of ring.

Piston to cylinder bore clearance is one of those critical areas and it is imperative that the assembler knows how to take the measurement to double-check the machinist as confirmed by (Labore, 2017). Woś and Mikalski, (2011) affirmed that one of the key factors related to the demand for durable engine in transportation is the need to the limit thermo mechanical internal losses, wear, and lubricating oil consumption, which are in turn conditioned by the tribological behavior of the piston–cylinder assembly.

Dimkovski *et al, (*2012) affirmed that cylinder liner surface finish controls the frictional losses, oil consumption, and emissions of internal combustion engines to a large extent. In order to minimize such losses, it is imperative to improve the liner surface texture by a consistent and more productive finishing process.

3.4 Procedures employed by local artisans

The third objective of this study is to examine the procedures employed by the artisans within their application of engines rebuilt cylinder bores and piston ring end-gap using descriptive statistical-mean to analyze the data. Table 3 present the descriptive statistics to examine the procedures employed by the artisans within their application of engines rebuilt cylinder bores and piston ring end-gap.

Table 3- Descriptive Statistics to examine the procedures employed by the artisans within their application of engines rebuilt cylinder bores and piston ring end-gap.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Dial bore gauge is not an appropriate tool to check taper in cylinder bore	19	1.00	5.00	4.6000	0.81375
Out of roundness of cylinder bore cannot be compared with Original Equipment Manufacture's (OEM) specification	19	1.00	5.00	4.7333	0.74171
The piston bore to clearances are born out of assumption and does not meet Original Equipment Manufacture's (OEM) specification	19	1.00	5.00	4.0500	1.05997
Original Equipment Manufacture's (OEM) ring and-gap specification is hardly used to accommodate thermal	19	1.00	5.00	4.1333	0.97819

expansion at operating temperatures					
The surface finishes are not cross- hatch pattern and do not conform to Original Equipment Manufacture's (OEM) specifications	19	1.00	5.00	4.4333	0.77496
Calibrated instrument does not use in Original Equipment Manufacture's (OEM) specifications	19	1.00	5.00	4.5417	0.77672
Valid N (leastwise)	19				

Chen, (2017) suggested that precision finish boring is a critical process for machining an accurate cylinder for engine block. The geometrical accuracy of cylinders is defined by cylindricity, which is critical to the product performance. Using the cylinder bore in the engine block as an example, cylindricity is important for the engine power, oil consumption, and piston ring friction. The geometry of the cylinder bore should be as round as possible with little or no taper or variation vertically (Carley, 2019).

Piston to cylinder bore clearance is one of those critical areas and it is imperative that the assembler knows how to take the measurement to double-check the machinist as confirmed by (Labore, 2017).

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In order to test for the effect on clients after patronizing engine rebuild service from artisans, Analysis of Variance (ANOVA) was conducted to identify the difference of effect in the flaws made by these manufacturing firms. Hence, the following subsections explain the descriptive statistics, homogeneity test, F-statistic and multiple comparison test.

The Table 4 shows the descriptive statistics of errors made by manufacturers. It shows that the mean of Basic Theoretical Knowledge in what they are doing is very low (1.2707). The mean for OEM was also (1.1989) and the mean for Work Procedure (4.7544). This shows that multiple errors are being made by manufacturers when conducting their daily.

Table 5 shows the results for the homogeneity test. It shows most of the errors made across all cases were homogeneous or similar. This reveals that similar errors are made throughout the manufacturing industry of rebuild cylinder bore.

Table 4- ANOVA Descriptive

Descriptive

Errors by manufacturers

			Bootstrap[a]			
					95% Confidence Interval	
		Statistic	Bias	Std. Error	Lower	Upper
BTK	N	19	0	4	12	26
	Mean	1.2707	.0000	.010	1.2500	1.2857
	Std. Deviation	.04504	-.005	.018	.00000	.06413
	Std. Error	.01033				
	Lower Bound	1.2490				

	95% Confidence Interval for Mean	Upper Bound	1.2924				
	Minimum		1.14				
	Maximum		1.29				
OEM	N		19	0	4	12	26
	Mean		1.1989	.0001	.004	1.1905	1.2062
	Std. Deviation		.01696	-.003	.007	.00000	.02631
	Std. Error		.00389				
	95% Confidence Interval for Mean	Lower Bound	1.1908				
		Upper Bound	1.2071				
	Minimum		1.14				
	Maximum		1.24				
wp	N		19	0	3	12	25
	Mean		4.7544	-.0003	.083	4.5833	4.9073
	Std. Deviation		.35732	-.0158	.064	.19213	.43728
	Std. Error		.08198				
	95% Confidence Interval for Mean	Lower Bound	4.5822				
		Upper Bound	4.9266				
	Minimum		4.00				
	Maximum		5.00				
Total	N		57	0	0	57	57
	Mean		2.4080	.0047	.2184	1.9958	2.8100
	Std. Deviation		1.68659	-.015	.093	1.46320	1.81217
	Std. Error		.22339				
	95% Confidence Interval for Mean	Lower Bound	1.9605				
		Upper Bound	2.8555				
	Minimum		1.14				
	Maximum		5.00				

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 5- Test of Homogeneity of Variances

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Errors by manufacturers	Based on Mean	36.753	2	54	.000
	Based on Median	8.116	2	54	.001
	Based on Median and with adjusted df	8.116	2	18.646	.003
	Based on trimmed mean	27.521	2	54	.000

The test for the effect of the flaws on clients after patronizing engine rebuild service from artisans revealed that with a confidence level of 95% ($p < 0.05$), there was a significant difference between the three groups which is with an $F = 1811.073$ with respect to how their errors made has affected the satisfaction of clients. This shows that the errors made differently and significantly affect client's satisfaction. This is seen in Table 6.

Table 6 - ANOVA

ANOVA

Errors by manufacturers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	156.956	2	78.478	1811.073	.000
Within Groups	2.340	54	.043		
Total	159.296	56			

To determine which errors mostly affect the clients' satisfaction, a multiple comparison test (LSD) was conducted. This test made bare errors made in the work procedure has a stronger effect on the clients' than its other counterpart. This is proven by the LSD of WP (Work Procedure) resulting -3.55544 with a p-value of 0.000. (See Table 7).

Table 7- Multiple comparison table

Multiple Comparisons

Dependent Variable: Errors by manufacturers

LSD

(I) Classification of errors	(J) Classification of errors	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
BTK	OEM	.07173	.06754	.29	-.0637	.2071
	wp	-3.48371*	.06754	.00	-3.6191	-3.348
OEM	BTK	-.07173	.06754	.29	-.2071	.0637
	wp	-3.55544*	.06754	.00	-3.6908	-3.420
wp	BTK	3.48371*	.06754	.00	3.3483	3.6191
	OEM	3.55544*	.06754	.00	3.4200	3.6908

*. The mean difference is significant at the 0.05 level.

4. Conclusion and Recommendation

The research sort to determine whether local artisans are theoretically knowledge oriented about cylinder bore re-manufacturing specifications. The study examined how the artisans adhere to OEM specifications for cylinder bore. It also found out the flaws within their application of cylinder bores. The research focused on the descriptive survey design to gather information from the local artisans in order to describe and document aspects of a situation as it naturally occurs. This design was applied by designing a questionnaire to collect data from the sampled population.

The findings show that the error rate of a bad engine tends to be high when Original Equipment Manufacture's (OEM) specifications are ignored by local artisans. The findings also implies that ring end-gap specifications are largely brushed aside by most of these artisans and this goes a long way to affect the maximum sealing of the combustion chamber. This also implies that most mechanics are unfamiliar with engine problems in assembly and replacement engines.

Moreover, finding on sleeve surface finish implies that most of the artisans take delight in ensuring a smooth or mirror finish rather than conforming to cross hatch surface finish. It was also revealed that most of these artisans do it out of ignorance and they cannot be blamed for such errors since that's exactly how they have been taught by their predecessors. A good surface finish ensures good oil lubrication of the pistons and rings, allows smooth break-in into the cylinder walls and therefore enhances the complete seal of the combustion chamber. In order to minimize such compression losses, it is imperative to improve the liner surface texture by a consistent and more productive finishing process. Failure to adhere to ring end gap specification may cause the ring ends to butt up and engine failure will occur. It is implied that our local artisans did not adhere to strict remanufacturing specifications.

Finally, findings of this research shows that because the local artisans fail to apply the basic theoretical knowledge, OEM's specifications and appropriate work procedure it goes a long way to affect the final customer. Hence, it can be concluded that flaws in the work procedure of rebuilding cylinder bore significantly affects clients' satisfaction.

5. Conclusion

The conclusions obtained by the researchers, after conducting this research are: Researchers have succeeded in making an android application prototype. This android application can help cattle sellers to sell livestock products to consumers so that they can increase their livestock sales. This application can help consumers find cattle and can compare prices between fellow cattle sellers. This application can facilitate transactions between sellers and consumers so that they can avoid fraud in transactions. From the results of the questionnaire, sellers and consumers agree with this android-based application. With the many benefits that can be obtained, of course the application must be developed more optimally, especially in terms of server infrastructure, because there will be many who access the Android-based application. Continue to improve the security of the application so that consumers feel more comfortable in using it. It is hoped that in the future it will not only sell cattle, but also sell other livestock such as goats, chickens, ducks and others.

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