Available online at 2019.creative-construction-conference.com/proceedings/

CCC 2019

Proceedings of the Creative Construction Conference (2019) 058

Edited by: Miroslaw J. Skibniewski & Miklos Hajdu

https://doi.org/10.3311/CCC2019-058

Creative Construction Conference 2019, CCC 2019, 29 June - 2 July 2019, Budapest, Hungary

Professionals View on Drivers That Enhance the Development of Remanufacturing in Nigeria

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Abstract

This study seeks to determine the drivers of remanufacturing from the professional's view. The methodology used for this study is the quantitative methodology, a mean item score and a normality test to determine their views and finally used the Mann-Whitney test to determine the views of the professionals. Findings from this research method revealed that there was no significant difference in the way; professionals viewed the drivers of remanufacturing. Further discussed was the implication of the findings, which revealed that the major driver of remanufacturing in Nigeria is the creation of job opportunities, which is vital as Nigeria is presently grappling with a high unemployment rate. Finally, it was concluded with the role remanufacturing will aid with the high unemployment in Nigeria.

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Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2019.

Keywords: Type your keywords here, separated by semicolons ;

1. Main text

Remanufacturing is defined as an industrialised process where parts described as cores which have reached their end of life are restored to useful life or almost new [1]. Steps are taken to restore the End of life products namely; inspection, disassembly, part replacement/refurbishment, cleaning, reassembly and testing to ensure the standard desired for remanufacturing is met [2]. A good knowledge of drivers is very necessary in order to develop appropriate strategies and policies for the development of remanufacturing in Nigeria. Studies carried out by Cunha et al (2011)[3] revealed that End of life regulations, increasing reusability, economic viability, OEM remanufacturing, new markets, product service systems, remanufacturing inside users, new demand, green labelling and certifying by association are some of the drivers of remanufacturing that could help develop and grow the remanufacturing industry. Further supported was studies carried out by [4] for drivers of remanufacturing in Greece revealed that customer service, green image, competition, profitability and legislation are some of the drivers by which remanufacturing is practised in Greece. In Finland [5] found that the drivers for remanufacturing include profitability, reduction of environmental impact, existing demand for remanufactured products, compliance with legislation, third parties remanufacturing products. In Sweden, [6] concluded the results of the research on drivers of remanufacturing include improving turnover, competition,

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strategic advantage, green image, asset production, environmental legislation, and ecological motivation. The aim of this study is to identify the drivers of remanufacturing in Nigeria from the professionals' view.

2. Methodology

Respondents were requested to indicate the degree of importance of each of the drivers of remanufacturing that play a role in the transition of a green economy based on a five-point Likert scale (strongly agree = 5, agree = 4, neutral, = 3, disagree = 2, strongly disagree = 1). Ninety-eight complete questionnaires were received signifying an 81% response rate.

The demographics of the respondents indicated that the majority of the respondents who participated in this survey were of the age range from (26-30) years to (31-35) years and had a work experience of (2-5) years and (6-10) years in the manufacturing industry.

Two statistical analysis were carried out namely descriptive statistics in the mould of (mean item score) and factor analysis. The mean item score was used to find the importance of the variables. Whilst factor analysis was used in establishing which of the variables could be measuring the same underlying effect. The procedure, findings and relevant discussion follow.

2.1. Presentation of the Findings

Factor analysis was employed to establish which of the variables could be measuring aspects of the same underlying dimensions. Factor analysis is useful for identifying clusters of related variables and thus ideal for reducing a large number of variables into a more easily understood framework [7]. Fig.1 presents the scree plot result. Average communality of the variables after extraction is as shown below; the Kaizer-Meyer-Olkin (KMO) measure of sampling adequacy achieved a high value of 0,833; the Bartlett test of sphericity was also significant suggests that the population matrix was not an identity matrix. Thus, the necessary tests in respect to the adequacy of the sample size were favourable for the factor analysis to proceed. Cronbach's alpha of 0,867 suggested the reliability of the study instrument used was good.

Table 1. Communalities

An example of a column heading	Initial	Extraction
C1.2	0.428	0.674
C2.2	0.315	0.240
C2.3	0.435	0.269
C2.4	0.377	0.434
C2.5	0.417	0.735
C3.1	0.563	0.630
C3.2	0.530	0.503
C3.3	0.454	0.385
C4.2	0.405	0.377
C4.3	0.537	0.517
C4.4	0.366	0.377
C5.1	0.318	0.277
C5.2	0.321	0.269
C5.3	0.439	0.489
C5.4	0.511	0.616
C5.5	0.522	0.573

C5.6	0.410	0.382
C5.7	0.587	0.602
C5.9	0.455	0.430
C5.10	0.557	0.562

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		
Bartlett's Test of Sphericity	Approx. Chi-Square	890.988
	df	253
	Sig.	0.000

The data was subjected to principal component analysis (with varimax rotation). The eigenvalue and factor loading were set at conventional high values of 1,0 and 0,5 respectively. As shown in table 3, six components with eigenvalues greater than 1. 00 were extracted using the factor loading of 0,5 as the cut-off point (see also scree plot in Fig 1). The total variance (see table 3) explained by each component extracted is as follows; factor 1 (32,925), component 2 (9,041), component 3 (6,970), component 4 (6,191), component 5 (5,040) and component 6 (4,854). Thus, the final statistics of the principal component analysis and the components extracted accounted for approximately 65% of the total cumulative variance.

Based on the examination of the inherent relationships among the variables under each component, the following interpretation was made component 1 was termed *Manufacturers attitude towards achieving green economy*; component 2 was termed *policies to drive remanufacturing*; component 3 was termed *benefits of driving remanufacturing*; and component 4 was termed *response to driving remanufacturing*; component 5 was termed *manufacturers drive to practise remanufacturing* lastly component 6 was termed *economic benefits of remanufacturing* These names were derived from the components by observation of the components and how closely related the variables are using the highest loading factor.

Normality test were performed on the compared groups to determine whether the y was normally distributed or not normally distributed. The cut-off significance for the normality tests used in this study was 0.05. The Kolmogorov-Smirnov statistic results would be used if the sample size were 50 and above. If the sample size is below 50, t h e Shapiro-Wilk statistics would be used.

In order to test whether there is a difference between the groupings, it is necessary to identify the null hypothesis and the alternative hypothesis.

H_0: Normally distributed

There is no difference between the groups

H_1: Not normally distributed

https://doi.org/10.3311/CCC2019-058

There is a difference between groups.

Conditions required to confirm if the variables are normally distributed or not normally distributed are: If P-value is greater 0.05. Do not reject H0 (accept H0) (Normally distributed) If P-value is less than 0.05. Reject H0 (accept H1) (Not normally distributed).

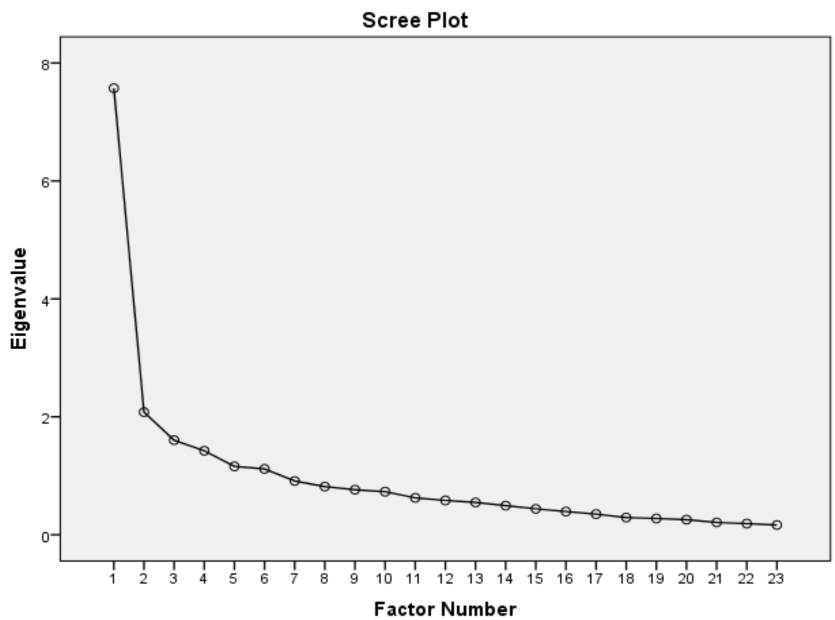

Table 3: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**7.573**	32.925	32.925	7.139	31.039	31.039	3.322	14.443	14.443
2	**2.079**	9.041	41.966	1.620	7.045	38.084	2.500	10.867	25.311
3	**1.603**	6.970	48.936	1.119	4.864	42.948	2.133	9.274	34.585
4	**1.424**	6.191	55.127	.960	4.176	47.124	1.968	8.555	43.140
5	**1.159**	5.040	60.167	.663	2.882	50.006	1.384	6.016	49.156
6	**1.117**	4.854	**65.021**	.646	2.807	52.813	.841	3.657	**52.813**
7	.912	3.967	68.989						
8	.816	3.549	72.538						
9	.765	3.324	75.862						
10	.730	3.176	79.038						
11	.626	2.721	81.759						
12	[illegible]	[illegible]	[illegible]						

13	.548	2.382	86.674
14	.494	2.147	88.821
15	.440	1.912	90.732
16	.394	1.714	92.446
17	.350	1.522	93.968
18	.292	1.269	95.237
19	.276	1.199	96.436
20	.256	1.115	97.551
21	.209	.909	98.460
22	.189	.821	99.282
23	.165	.718	100.000

Extraction Method: Principal Axis Factoring

The normality test for *manufacturers' attitude towards achieving green economy* showed that the p-test for less than five years and five years or more indicated that it is less than 0.05. Hence H0 (Null hypothesis) was rejected and H1 (Alternative hypothesis) was accepted. Therefore, it is not normally distributed. **Conclusion**: The null hypothesis was rejected. Thus, there is a difference between the groups

On how they view manufacturers' attitude towards achieving a green economy. Next, the normality test for policies to drive remanufacturing showed that the p-test for less than five years and five years or more indicated that it is less than 0.05. Hence H0 (Null hypothesis) was rejected and H1 (Alternative hypothesis) was accepted. Therefore, it is not normally distributed. **Conclusion**: The null hypothesis was rejected. Thus, there is a difference between the groups on how they view policies to drive remanufacturing.

Secondly, the normality test for benefits of driving remanufacturing showed that the p-test for less than five years and five years or more indicated that it is less than 0.05. Hence H0 (Null hypothesis) was rejected and H1 (Alternative h hypothesis) was accepted. Therefore, it is not normally distributed. **Conclusion**: The null hypothesis was rejected. Thus, there is a difference between the groups on how they view the benefits of driving remanufacturing.

Thirdly, the normality test for response to driving remanufacturing showed that the p-test, for less than five years and five years or more indicated that it is less than 0.05. Hence H0 (Null hypothesis) was rejected and H1 (Alternative hypothesis) was accepted. Therefore, it is not normally distributed. **Conclusion**: The null hypothesis was rejected. Thus, there is a difference between the groups on how they view the response to driving remanufacturing.

In addition, the normality test for manufacturers driver to remanufacturing showed that the p- test for less than five years and five years or more indicated that it is less than 0.05. Hence H0 (Null hypothesis) was rejected and H1 (Alternative hypothesis) was accepted. Therefore, it is not normally distributed. **Conclusion**: The null hypothesis was rejected. Thus, there is a difference between the groups on how they view the manufacturers' drivers to practice remanufacturing.

Lastly, the normality test for economic benefits showed that the p-test for less than five years and five years or more indicated that it is less than 0.05. Hence H0 (Null hypothesis) was rejected and H1 (Alternative hypothesis) was accepted. Therefore, it is not normally distributed. **Conclusion:** The null hypothesis was rejected. Thus, there is a difference between the groups on how they view the economic benefits.

The Man-Whitney test is as shown below;

No significant differences in the manufacturers' attitude towards achieving green economy between less than five years (MD = 4.63, n = 52), and five years or more (MD = 4.75, n = 42), (U = 1009.500, z = -1.339 p = 0.181);

No significant differences in the policies to drive remanufacturing between less than five years (MD = 4.55, n = 52), and five years or more (MD = 4.40, n = 42), (U = 1103.000, z = -0.685, p = 0.493);

No significant differences in the benefits of driving remanufacturing between less than five years (MD = 4.75, n = 52), and five years or more (MD = 4.75, n = 42), (U = 937.500, z = - 1.860 p = 0.063);

No significant differences in the response to driving remanufacturing between less than five years (MD = 4.00, n = 52), and five years or more (MD = 4.25, n = 42), (U = 1071.000, z = - 1.024 p = 0.306);

No significant differences in the manufacturers' drivers to practise remanufacturing between less than five years (MD = 5.00, n = 52), and five years or more (MD = 5.00, n = 42), (U = 1071.000, z = -1.024 p = 0.306);

No significant differences in the economic benefits between less than five years (MD = 5.00, n = 52), and five years or more (MD = 4.50, n = 42), (U = 1100.000, z = -.787 p = 0.431).

3. Discussion of Results

Component 1: Manufacturers attitude towards achieving green economy

The eight extracted barriers of remanufacturing for component 1 were implementation of responsible consumption with (67,7%), achieving a zero landfill reduction with (64,1%), implementation of proper waste disposal of all products and services with (63,9%), achieving a low carbon footprint with (56,6%), multiple product lifecycles with (54,1%), reduction of greenhouse gas emission with (50,9%), prolong life cycle with (46,3%) and remanufactured goods can be sold as new with (42,4%). This cluster accounted for 32, 93% of the variance (see table 6). These criteria share a common link to as manufacturers' attitude towards achieving the green economy. *Achieving a zero-landfill reduction* as seen by Fuji Xerox is an example of a company which achieved zero landfills after Xerox adopted remanufacturing in the 1980s. Xerox achieved zero landfills in Japan in 2000. By employing a closed loop supply chain whereby, the products are recovered via customer take back policy which is then sent to the remanufacturing plant [8]. *Reduction of carbon footprint* is another driver for remanufacturing. In 2005 Caterpillar Global Remanufacturing Operation collected and reused 43 million tonnes of core material, thereby preventing 52 million tonnes of CO2 emission into the ecosystem [9]. In comparison to other forms of product recovery management, remanufacturing of products will retain all the value [10] functional characteristics, *multiply the lifecycle of the product*, so potentially it has a high level of sustainability and considered as the best way of recovering product' (BWPR).

Component 2: policies to drive remanufacturing

The five extracted barriers of remanufacturing for component 2 were the implementation of initiatives for conservation environment with (72,8%), new market development opportunities (71,3%), pollution control measures with (58,7%), broaden product market research with (50,0%) and product warranty is assured (45,8%). This cluster accounted for (9,04%). Subsequently, this component was labelled policies to drive. Studies have shown that one of the major drivers for remanufacturing is the involvement of government in developing policies to encourage remanufacturing as seen by countries like China, USA. Remanufacturing can be favourable to manufacturers as they seek to broaden their market in search of consumers who then cannot pay for the high cost of new products [11]. According to [12], components used for remanufacturing process are either from the same or from other products. This reduces the use of new components, saves resources, materials, energy and other inputs. Other economic drivers are the assured warranty, life expectancy as good as new, high- quality products, and competitive price which can lead to new market development opportunities as remanufacturers target a specific market audience.

Component 3: Benefits of driving remanufacturing

The four extracted barriers of remanufacturing for component 3 were the creation of job opportunities (71,2%), conservation of natural resources with (56,8%), improve profitability

(51,7%), commitment to maintain environmental balance (44,6%). This cluster accounted for 6, 97%. Subsequently, this component was labelled *benefits of driving remanufacturing.* Sale on remanufactured products can give profit margins as high as 40 percent [13] thus leading to *improve profitability*. Remanufacturing plays a major role in the society as a whole [13]. Products returned are always an economically feasible option (technical and physical upgrade) simultaneously benefiting the society by providing skills in terms of *Job creation* [14]. Ozer (2012)[15] stated that remanufacturing of products is a means of creating profit for the organisation and at the same time brings about benefits to the environment. This benefit brings about a commitment to maintain environmental balance.

Component 4: Response to driving remanufacturing]

For component four, four drivers were extracted. Which were; adequate and timely response to environmental impact with (73,9%), targets and reporting for environmental performance with (67,1%), the creation of a niche market with (56,8%) and portraying of green image organisation with (54,6%). Portraying of a green image by the organisation is the reason why remanufacturing is adopted by the organisation [16].

Component 5: manufacturers drive to practise remanufacturing.

For component five, one driver was extracted. Which were lower production costs with (66,4%) is Significant lower input cost is an economic driver of remanufacturing since cores used in remanufacturing of products are reused [17].

Component 6: Economic Benefits of remanufacturing

For economic six, one driver was extracted. Which were original state of the product is retained with (35,5%)

Discussion of the Mann-Whitney test

From the Mann-Whitney test, the working experience was also compared to see the distribution regarding manufacturers' attitude to green manufacturing against working experience (comparing less than five years and five years and more). Results showed that there was no significant difference between less than five years working experience and five years and more working experience (U=1009.500, z= -1.339, p =0.181). Secondly, comparison of policies to drive remanufacturing against work experience (less than 5 years against five years and more) showed that there was no significant difference (U=997.000, z= -0.028, p =0.978). Thirdly, Comparison of benefits of driving remanufacturing against work experience (less than 5yrs and 5yrs and more) revealed that there was there was no significant difference (U=1103.000, z= -0.685, p =0.493). Furthermore, comparison of response to driving remanufacturing against work experience (less than 5yrs and 5yrs and more) revealed that there was no significant difference (U=937.500, z= -1.860, p =0.063). comparison of manufacturers' drivers to practice remanufacturing against work experience (less than 5yrs and 5yrs and more) showed that there was no significant difference (U=1071.000, z= -1.024, p =0.306). Finally, Comparison of economic benefits against working experience showed that there was no significant difference (U=1100.000, z= -0.787, p =0.431).

3.1. Findings

The empirical finding of this study is consistent with the findings of [18] who revealed that one of the drivers of remanufacturing is its ability to create job opportunities Following drivers for remanufacturing is the achieving of low carbon footprints which is consistent with the study carried out by the Caterpillar Global Remanufacturing Operation which collected and reused 43 million tonnes of core material and prevented 52 million tonnes of Co2 emission inflowing into the ecosystem [19] The reduction of GHG emission is consistent with the study carried out by APRA. The process of remanufacturing has been shown to conserve energy to the sum of trillions of British Thermal Units (BTUs) each year. Thus, remanufacturing lessens the amount of greenhouse emission 20]. A comparison test was carried out to examine whether biographic play a significant role in the way the respondents viewed this research question and it was discovered that biographic doe s not play a role in all groups compared were of the same opinion on the drivers of remanufacturing.

3.2. Implications of result

From the above findings, it is evident that the major driver of remanufacturing in Nigeria is the creation of job opportunities which is vital as Nigeria is presently grappling with a high unemployment rate. Just as the world is struggling with the problem of carbon footprints, so also is Nigeria, hence the drive for the reduction of carbon footprint. Remanufacturing would be a driver as it seeks to reduce the carbon footprint. Furthermore, as Nigeria seeks to transition to a green economy, it is of importance that greenhouse gas emission is reduced, thereby increasing the importance of remanufacturing in its quest, to transition to a green economy. Achieving a zero-landfill reduction is one of the important drivers of remanufacturing as achieving of a zero landfill makes cores available for remanufacturing, thereby leading to an improvement in profitability for remanufacturers.

4. Conclusion

From the primary data, results have shown that creation of job opportunities is seen as a major driver for the development of remanufacturing in Nigeria as Nigeria is grappling with a high unemployment rate, followed by achieving of low carbon footprint, as respondents saw this as a way to transit to a green economy, reduction of greenhouse emission, achieving a zero-landfill reduction. Findings from the questionnaire indicated that creation of job opportunities, achieving of low carbon footprint, reduction of greenhouse gas emission and achieving a zero-landfill reduction.

The drivers of remanufacturing can be classified into six clusters namely Manufacturer's attitude towards achieving green economy, policies to drive remanufacturing, benefits of driving remanufacturing, response to driving remanufacturing, manufacturers drive to remanufacturing and economic benefits of remanufacturing These findings lend support to the possible ways to drive remanufacturing in Nigeria.

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