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PRODUCTIVITY PATTERN OF WARRI REFINING AND PETROCHEMICAL COMPANY (WRPC) LIMITED: A PRINCIPAL COMPONENT ANALYSIS APPROACH

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ABSTRACT

Crude oil is a natural endowment to the people of Nigerian. Hence, refineries were positioned to provide finished petroleum products to both domestic use and for export. Till date, Nigeria still depends largely on the importation of petroleum products for both domestic and industrial applications. The aim of this research work therefore, is to find out the possible causes of this downward trend in the productivity pattern of our Refineries using WRPC as a case study. A survey approach was adopted in this work using questionnaires. Experts in the oil and gas industries were briefed and debriefed on the purpose of the work. A data matrix of 35 by 50 was generated from the questionnaires administered. This data matrix formed was used as the input data for the principal component analysis (PCA) using statisti-XL soft ware. The PCA used facilitated the formation of the factor matrix, scree plot and the transformation matrix. The result of the study showed that regional insecurity, chronic vandalism, managerial constrain, government policies, epileptic power supply and dearth of infrastructural facilities among others were the major factors influencing to a greater extent the productivity pattern of the WRPC among others.

INTRODUCTION

Nigeria is a country blessed with natural resources; she is also endowed with human and economic resources. Ironically, in spite of all these natural gift, the people bounded by that geographical enclave called Nigeria suffers in the mist of abundant resources. A serious, important and a pathetic situation is the unavailability of refined petroleum products for end users among other myriads of problems. Warri Refinery and Petrochemical limited is one of the companies whose mandate is to provide these products at reasonable price to their host in particular and Nigerians at large. Unfortunately, they have failed in this regard in spite of the available manpower, sophisticated equipment and availability of crude oil among others. Undoubtedly, petroleum products distribution is key to national development. This is principally because of its wide applications in both domestic and industrial purposes. However, the near zero supply of these petroleum products has caused our country a national embarrassment and again endless sufferings to the populace.

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This paper seeks to find out the causes of this downward trend in the production and distribution of petroleum products on one hand and to proffer possible solutions to this ugly trend on the other hand. In doing this, we implore the principal component analysis method using Statisti XL software which is a veritable tool in analyzing and grouping variables into independent clusters that aid creative labeling and interpretation. However, some notable researchers had worked in the past to establish the major problems responsible for inconsistent nature of production in Warri Refining and Petrochemicals.

Amongst them are, Badmus et al.(2013), the paper appraised the energy consumption and utilization level of Warri Refinery and Petrochemicals limited. The paper concluded that about 70 percent of the energy used in WRPC was for utilities and maintenance thereby making available less than 30 percent for productive purposes. This is a far cry from what is required to produce at installed capacity. In a related development, Ashiedu and Igboanugo (2011a) used the principal component analysis (PCA) to ascertain the accessibility and mobility requirements of paraplegics in a built up environment. The result of the study highlighted factors such as death of infrastructural facilities, absence of appropriate mobility aids and government policies among others.

In a related work, Igboanugo et al. (2016) carried out a factorial study of the corporate performance of Nigerian Refineries and opined that for NNPC to meet up with the desired expectations, omnium-gatherum a gamut of variables that trumped significantly be factored into their aggregate planning. Similarly, some notable works in the area of using linear programming and mixed integer linear programming models as mathematical tool in fixing refinery planning and optimization problem was carried out by Lee, et al. (1996) and Joly, et al. (2002). Again, on the significance of PCA, Tapani et al. (2008) observed that the PCA is a classic technique in data analysis. The paper added that the PCA is used to compress higher dimensional data set to lower dimensional one for data analysis, visualization, feature extraction and or data compression. Another latent but important quality of the PCA include the minimization of the mean square error in data compression, locating mutually orthogonal directions in data having maximal variances and finally, decor relation of the data using orthogonal transformation, Igboanugo and Ashiedu, (2011b). Also concerned about the productivity pattern of PPMC includes, Alaba and Agbalajobi (2014), their work examined the impact of human resource management on planning and marketing in product marketing company Ekpan (PPMC). The result of the examination showed an imbalance in the allocation of human resources to various unit of the company which significantly affects productivity.

Interestingly, Myloni et al. (2004) reported that the role of Human Resource Managers as strategic partners in formulating and implementing organizational strategy includes workforce planning, job analysis, manpower training and development, recruitment and selection of appropriate factors of production with the assistance of other relevant bodies. This finding was corroborated by Chang and Chen (2002) and Christopher and Adepoju (2012). The study Oladejo and Macaulay (2014) examined the relationship between plant failures and industrial accidents in Kaduna Refinery and Petrochemicals Limited, the study then provided a mathematical model to forecast the yearly man – hour worked in (KRPC). This findings as pointed out by the paper will aid proper, effective and efficient planning in KRPC. Also, Tessema and Soeters (2006) investigated the challenges and prospects of human resources management in developing countries using Eritrea as a case study.

METHODS

The method adopted for this research is the survey approach using Rensis Likert Attitudinal scale. The respondents were drawn from staff of the Warri Refining and Petrochemical Company Limited, Petroleum Training Institute and Federal University of Petroleum Resources Effurun, all in Warri metropolis. The high level of experience and knowledge in the oil and gas operation of the selected respondents justified their candidature in this work. A total of seventy respondents were drawn from the three institutions. Out of this number, a total of fifty questionnaires were returned. The questionnaire consist of thirty five questions crafted from the variables used to develop a fifty by thirty five (50 by 35) matrix. In order to guarantee content validity, the respondents were briefed and debriefed before and after the administration of the questionnaire respectively. The scale items used for the research work are shown in Table 1. The use of Rensis Likerts Attitudinal scale enabled the transformation of respondent's option into metric variables. This metric variable is important in that it measures the degree of possession of each attributes. The data matrix generated serve as input data to the principal component analysis, where Statisti XL software was used to generate parameter estimate, correlation matrix and factor matrix. Factor loading in the factor matrix less than 0.5 are disregarded for interpretation since the factors solution are orthogonal and independent of each other. From the factor matrix rotation, a total number of eleven (11) factors with their respective surrogate variables were formed. These factors were creatively labeled to aid the interpretation of factors responsible for the productivity pattern of the WRPC. More so, the PCA is one of the oldest and the most efficient statistical tool in interpreting multivariate variables; this justifies its use in a study of this type.

The mathematical theorem governing the use of PCA in the extraction, description, processing and analyzing information from available data is as presented below.

$$if\ x = matrix\ singular\ decomposition, then\ x = P\Delta Q^T \quad (1)$$

Where

$P = 1\ x\ L\ \ Matrix\ of\ left\ singular\ vector$
$Q = J\ x\ L\ \ Matrix\ of\ right\ singular\ vector$
$\Delta = Diagonal\ matrix\ of\ singular\ value$

Also

$$\Delta^2 = \cap \quad (2)$$

$$where\ \cap\ is\ the\ diagonal\ matrix\ of\ the\ non-zero\ eigenvalues\ of\ X^TX\ \ and\ XX^T$$

Where

$$X^TX\ = covariance\ matrix$$
$$XX^T = correlation\ matrix$$

The data to be analyzed by PCA is made up of I observations, described by J variables, represented by $IxJ\ matrix$.

The generic element for X is given by

$$X = x_{ij}$$

Also, the matrix 'X' has rank denoted by 'L', however,

$$L \leq min\{IJ\}$$

The inertia of column is computed as

$$I_j^2 = \sum_i^1 x_{ij}^2 \quad (3)$$

Also, the Euclidean distance of thei-th observation to the centre of gravity (g) is given by

$$d_{ig}^2 = \sum_j^j (x_{ij} - g_j)^2 \quad (4)$$

But when we have a central data equation 4 reduces to

$$d_{i.g}^2 = \sum_j^j x_{ij}^2 \quad 5$$

RESULTS

The result generated from the study as shown in Table 1, and 2 are the varimax rotation and the component transformation matrix respectivily.

Similarly, the scree plot is detailed below in figure 1. The plot is done using the Eigen values against the component number otherwise referred to as the variable number. From the plot, it is seen that there exist a steep slope along the eigen axis, while the slope tend to become more gentle from component number 8 to 35. This again explains the degree of relevance of each variable to the overall effects on each gamut of variables. Pictorially, the pie chart shown in figure 2 is a detailed contributions of each variables in percentage to the perceived productivity pattern of WRPC.

Table 1. Thirty five scale items on productivity pattern of WRPC

Item No.	Scale item	Item No.	Scale item	Item No.	Scale item
1	Corruption among staffs	13	Unqualified personell	25	Production associated risk
2	Lack of spares	14	Motivation	26	System reliability
	Lack of manpower	15	Bad maintenance policy	27	Modern trend/ facilities
4	Unavailability of crude oil	16	Lack of required skills	28	Variations in demand
5	Crude theft	17		29	Low returns on investment
6	Activities of illegal refineries	18	Visionless staffs	30	Production equipment
7	Restiveness/ insecurity	19	Experience required	31	Official bureaucracy
8	Bottlenecks in decision making	20	Lack of infrastructural facilities	32	In house policies and politics
9	Political instability	21	Sabotage among staffs	33	inflation
10	Government policies	22	Unionism	34	Leadership style
11	Funding	23	Absence of expatriate	35	Work hazards
12	Inadequate power supply	24	Workers attitude		

Table 1: Varimax Rotation

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Comp	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	factor7	Factor 8	Factor 9
1	0.550	0.395	0.427	0.255	0.172	0.005	0.214	0.351	0.202
2	-0.516	0.199	0.169	0.492	0.428	-0.240	-0.321	-0.108	0.219
3	0.298	-0.289	-0.245	0.346	-0.304	-0.549	0.115	-0.240	0.218
4	-0.224	0.655	-0.483	0.126	-0.301	0.243	0.261	-0.059	0.092
5	-0.063	-0.288	0.132	0.157	-0.242	0.496	0.004	.0151	0.599
6	-0.133	-0.265	-0.156	0.485	0.163	0.053	0.575	.0066	-0.115
7	0.337	-0.083	-0.626	-0.006	0.601	0.183	-0.183	.0143	0.087
8	0.001	-0.221	-0.067	0.359	-0.240	0.329	-0.464	.0177	-0.176
9	-0.361	-0.244	0.034	-0.160	0.127	-0.059	0.350	.0507	-0.148
10	0.134	-0.062	0.234	0.195	0.170	0.420	0.179	-0.563	-0.394
11	-0.96	-0.137	0.034	-0.325	0.234	0.109	0.189	-0.389	0.517

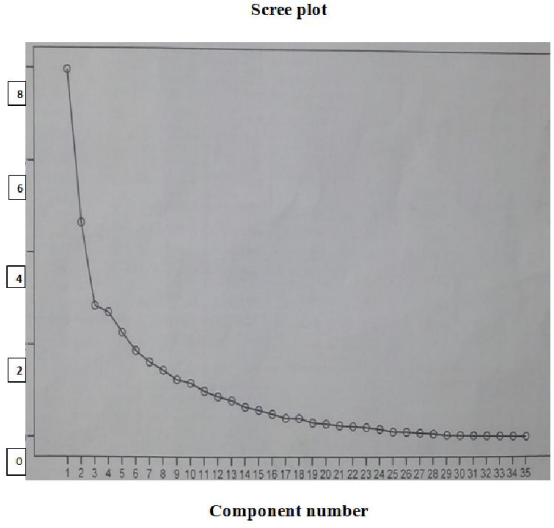

Figure 1. Scree plot

Table 2. Component transformation matrix

Component Transformation Matrix

Component	10	11
1	0.226	0.056
2	-0.043	0.131
3	0.078	0.361
4	0.112	0.174
5	-0.406	0.136
6	-0.002	-0.524
7	-0.106	0.143
8	0.611	-0.029
9	0.195	0.569
10	-0.065	0.415
11	0.580	-0.090

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

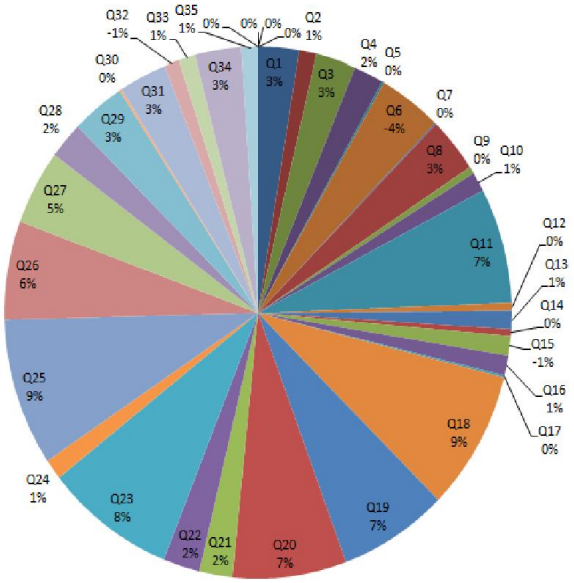

Figure 2. Pie chart showing contributions of various variables

The following clusters of variables also referred to as platoons were generated from the study with the aid of statisti Xl software. The general and latent implications of each platoon with regards to the productivity pattern of the Warri Refining and Petrochemicals Limited are discussed below.

Platoon 1. Regional Insecurity

Variable numbers	Variables	Factor loadings
7	Restiveness/ insecurity	0.901
2	Lack of spares	-0.654

Among the entire clusters, variable number 7 has the highest factor loading of 0.901. This means that restiveness and insecurity in the Niger, Delta region is one of the most significant factors responsible for the low productivity pattern of the Warri Refining and Petrochemicals.

This region is noted for all forms of criminality all in the guise of regional resource control. Most times, government on their own nurture, encourage and sustain some of these criminal elements in the creek for political advantage over opposition parties. This again is one of the reasons why it is often difficult to eliminate some of these observed problems. The second variable which is a middling with a factor loading of -0.654 is indicative of the fact that unavailability of spares as at present is not a major factor militating against the productivity nature of WRPC, however, effort should be made at all times to see that all spares needed for operations at all times as occasioned by the company's inventory models are provided otherwise, it could trump a latent. Other social vices in this region include kidnappings and high powered robberies among others.

Platoon 2. Managerial constrain

Variable numbers	Variables	Factor loadings
30	Production equipment	0.868
21	Sabotage among staffs	0.814
32	In house policies and politics	0.652
16	Lack of required skills	0.533
27	Application of modern in production	0.461

As at the moment, respondent believed that the equipment available for production purposes do not meet the desired standard. It is of their view that sophisticated, highly reliable and equipment with high mean time to failure be provided. Similarly, managers of resources must as a matter of urgency identify areas of wastages among staffs and equipment with a view to finding a lasting solution to the issue of sabotage in our work places. The other variables in the platoon are middling's.

Platoon 3. Chronic Vandalism

Variable numbers	Variables	Factor loadings
5	Crude theft/ vandalization	-0.845
1	Corruption	0.794
6	Illegal refineries	0.636
24	Workers attitude	0.430

Crude theft and vandalism in the region under investigation is a major reason why WRPC has failed in its mandate to provide uninterrupted supply of petroleum products to Nigerians. Also significant in this platoon is corruption among staffs of WRPC. This has a factor loading of 0.794, suggesting that it must be tackled sincerely before any meaningful progress in terms of increase in service delivery can be attained. This in turn may influence increase in production in the region.

Platoon 4. Unsteady Government Policies

Variable numbers	Variables	Factor loadings
10	Government policies	0,842
17	Sabotage among outsiders	0.569

Over the years, government policies are not steady even within the same political party in power. Once there is a change in leadership, the policy direction also changes, this changes affects all aspect of growth within the economy.

Respondents are of the view that policies must remain steady irrespective of variations in the type and nature of the person in power and that of their political affiliations. The respondents are of the view that the positive effects of policy sustainability within a defined period of time should be maintained, nurtured, protected and guided jealously to fruition irrespective of the type, kind and nature of the managers of the economy.

Platoon 5. Epileptic Power supply

Variable numbers	Variables	Factor loadings
12	Power supply	0.876

This is another variable that is meritoriously loaded with a factor loading of 0.876 in platoon 5. Respondents are of the view that electricity is key to high productivity. This is because power is required to provide activation energy to all equipment and machines required for production. It is their view also, that if the power problem is fixed in this region, then increase output may be feasible not only in the petroleum sector but all other sectors that may require constant power supply for its day to day operations.

Platoon 6. Dearth of infrastructural facilities

Variable numbers	Variables	Factor loadings
3	Man power required	0.814
4	Interrupted supply of crude oil	0.724

Variables no 3 and 4 with factor loadings of 0.814 and 0.724 respectively are critica in addressing the growth and potential of any commercial establishment. Unfortunately, manpower supply required to optimize the use of most machines used for production purposes are not always available for use. This therefore creates a scenario where machines and equipment available in the company are permanently kept redundant. To further worsen the situation, the supply of crude oil which is the major raw material for WRPC is near zero on a daily basis as a result of myriads of issues ranging from vandalism, dearth of infrastructural facilities, sabotage and a host of others.

Platoon 7. Economics in Ergonomics of design

Variable numbers	Variables	Factor loadings
25	Work hazards	0,823
18	Visionless staff	0.781
23	Expatriates involvement	0.762
20	Infrastructural decay	0.667
11	Poor funding	0.643
19	Experience	0.637

The result showed that the problem associated with poor or low productivity is not directly linked with the people's experience, the nature of funding from government and lack of infrastructure, rather, the work related hazards and the general altitude of workers in the organization. This again is a problem of proper work study and workplace design. The respondents are of the view that the economics in ergonomic of workplace design must be identified and addressed to highlight its economics for both management and staffs. When this is effectively done, increase performance in the productivity level of WRPC may be near high.

Platoon 8. Economic Condition

Variable numbers	Variables	Factor loadings
33	Inflationary trend	0.899
31	Official bureaucracy	0.701
34	Leadership style	0.646
22	Trade union	0.510

Variable no. 33 with a factor loading of 0.899 duel more on the inflationary trend of Nigeria economy as a country. The exchange rate is highly unpredictable; it varies from time to time. it is the view of the respondents that if the national currency can be stabilized for a reasonable length of time then, proper planning and implementation will protect and enhance the activities of WRPC to a greater extent.

Platoon 9. political instability

Variable numbers	Variables	Factor loadings
	Political instability	0.794
29	Low return on investment	0.652
26	Systems reliability	0.558

This is a bipolar factor outscoring the need for steady pursuit of government programmers as it concerns WRPC. Well made plan should be sustained at all times no matter the political party that is in power. Changes should not be made for political settlement as it were in the past. It should be based on experience, integrity, track records and service delivery. These are the views of the respondents. Variables no 29 and 26 are middling's that needs to be observed even though they are not critical in nature.

Conclusion

This work was aimed at identifying the gamut of variables responsible for the horrid state of production activities in WRPC using the PCA model. That to a greater extent has been achieved and the critical factors militating against the activities of WRPC have been identified. This may form part of the much needed policy document for government, policy makers, nongovernmental organizations and certainly, multinationals. Certainly, the authors are of the view that if these critical items as extracted and analyzed are holistically, religiously, efficiently and truthfully addressed, the issue of near zero performance indices in the WRPC will be a thing of the past. All relevant bodies are therefore advised to address these key issues raised so as to optimize all relevant factors of production required to boost productivity in WRPC.

REFERENCES

Alaba, O. C. and Agbalajobi, S. A. 2014. ''Human Resource Management for Effective planning and Marketing of Petroleum products (A case study of PPMC Ekpan, Warri Delta State, Nigeria). *International journal of Engineering and Technology*, vol. 4 No 9, pp 549 – 557

Ashiedu F. I. and Igboanugo A.C. 2011. 'A Factorial Study of Accessibility Requirements for Paraplegics Mobility in Built Up Environment'. *Journal of Innovative Research in Engineering and Science*, Vol. 2 no. 1, pp: 29-43.

Badmus, I. Fagbenle, R.O. and Oyewola M. O. 2013. An Appraisal of Process Units Energy Uitilization Pattern in Nigeria Refineries, Warri Refining and Petrochemicals Company Case Study.

Chang, P. I. and Chen, W. I. 2002. ''The Effect of Human Resource Management Practice on Firm Performance, *International Journal of Management* Vol. 19, No 4, pp 622 – 638

Christopher, E. and Adepoju, A. 2012. ''An Assessment of the Distribution of Petroleum Products in Nigeria, *Journal of Business Management and Economics*. Vol. 3 No. 6, pp 232 – 241

Igboanugo Anthony C and Ashiedu Festus, 2011. Contextualization of Entrepreneurial Education in Production Engineering Discipline. *Journal of Emerging Trends in Education and Policy Studies,(JETERAPS) Vol. 2 (6) pp (602 – 607)*

Igboanugo, A. C. Garuba O. M. and Okafor T. L. 2016. A Factorial Study of Corporate Performance of Nigerian Refineries. *Nigerian Journal of Technology* (NJOTECH) Vol. 35, No 1, pp 71 – 79.

Joly, M. Moro, L. F. and Pinto, J. M. 2002. ''Planning and scheduling for Petroleum refineries using mathematical programming'' *Brazil journal of Chemical Engineering* vol. 19, pp 207 – 228

Lee, H., Pinto, J. M., Grossmann, I. E. and Park, S. 1996. ''Mixed Integer Linear programming model for Refinery Short Term Scheduling of Crude Oil Unloading with inventory Management'' *Industrial and Engineering Chemistry Research* vol. 35, pp 1630 – 1641.

Myloni, B. Harzing, W. K. and Muza, H. 2004.''Host Country Specific Factors and the Transfer of Human Resource Management Practices in Multinational Companies'' *International Journal of Manpower*, vol. 25, No 6, pp 518 – 534

Oladejo, J. O. and Macaulay, M. O. 2014. ''Determination of Kaduna Refining and Petrochemicals Company Limited (KRPC), Journal of Mathematics, vol. 10, No 1 Pp 42 – 45

Tapani, R. Alexander, L. and Kharhumen. 2008. ''Principal Component Analysis for Sparse High Dimensional Data, Adaptive information Research Centre, Helsinki University of Technology

Tessema M. T. and Soeters, J.I. 2006. ''Challenges and prospectus of HRMin Developing Countries'' Testing the HRP. Performance Link in Eritrean Civil Service'' *International Journal of Human Resource Management'* Vol. 17, No 1 pp 86 -105.

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