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ECO INNOVATION IN CASSAVA GRATING MACHINE DESIGN

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ABSTRACT

Eco-innovation is the development of products and processes that contribute to sustainable development, applying the commercial application of knowledge to elicit direct or indirect ecological improvements. Innovation by businesses to reduce their environmental impacts or improve the environment (so called eco-innovation) is an essential ingredient to creating a green, healthy and wealthy future Reducing environmental impact is also important for a business' bottom line, Research shows that this activity is much more likely to translate into profit when businesses pay close attention to all the elements of their business model. Like all innovation activity eco-innovation is not just about new technology New methods of organizing a business or marketing products and services to customers can also reduce a business' broader impact on the environment. Cassava is a major source of carbohydrates in human diet. It is widely cultivated and serves as a major source of income in countries like Brazil, India and most West African countries. The tubers of cassava cannot be stored longer after harvest before decaying. Due to this short storage period of the tubers, cassava tubers are further processed into other forms to enhance its storage and to serve other purposes. In Nigeria, the major uses of cassava tubers is to process it into garri for Consumption and commercial purposes. The rate of garri consumption in Nigeria and West Africa at large increases tremendously that the quest for devising a means to get cassava processed into garri becomes an issue of great concern. This processing of cassava tubers into garri after harvesting involves different stages starting with the peeling, washing, grating into cassava pulp, dehydrating the pulp, sieving the cake and finally frying. One of these processes which is the grating process led to the development of this cassava grating machine. This project seeks to develop a better means of producing garri by using a mobile means and operated

power machine and also to design, modelling, simulation, and Sustainability analysis of cassava grating machine. Computer-based design analysis is nowadays a common activity in most development projects.

KEYWORD: Eco-innovation ,Cassava Grating , Design Process, Sustainability and analysis.

INTRODUCTION

In addition to improving the productivity or profitability of business operations, a focus on reducing environmental impact through innovation can increase market share or open up new markets. Many of these new markets are on Australia's doorstep. By 2030 the population of the world is projected to be over 8 billion. It is expected that countries will be struggling to meet the increased demand for energy, water and food while simultaneously meeting the environmental stresses of global warming, loss of species habitat, ocean acidification and over-harvesting of fauna and flora. These changes will create a large market for new environmentally sustainable products and services.

Many of the simple graters in use have been developed by local institutions. In the early 1970s a cassava grater was developed in the Intermediate Technology Development Group's workshop in Nigeria made from simple workshop spare parts and using hacksaw blades mounted on a vertical disc. It was driven by somebody peddling.. The "Wadwha" disc grater was developed in Ghana and consisted of a disc shaped wooden block to which a perforated metal sheet was nailed. The disc was driven by a 5 hp diesel engine shown in fig;2 and a through put of one tonne of cassava was claimed. The Tikonko Agricultural Extension Centre in Sierra Leone developed a vertical drum grater. The outer surface of the drum was covered with a sheet of perforated metal as shown in fig;8 and as it rotated the cassava was pressed against the grating surface by a wooden block shown in fig;9. The drum was powered by a 5 hp electric motor or diesel engine. In general capacities range between 300kg to 1,000kg per hour (Bencini, 1991). In Cameroon many of the cylindrical power graters used in villages are based on the design of

Which has some unique design features intended to improve grating efficiency and output without necessarily increasing the power requirement. There are, however, many variations in design, power transmission, capacity and type of construction. Garri is a fermented and gelatinized dry coarse flour, very popular in West Africa and a staple food in Nigeria, Ghana, Benin and Togo. Its ability to store well and its acceptance as a "convenience food" is responsible for its increasing popularity in the urban areas of West and Central Africa. It is often consumed as the main meal in the form of a dough or a thin porridge. Both are prepared in the household by mixing dry garri with hot or cold water and cooking and are served with soup or stew. Garri is also eaten as a snack when mixed in cold water with sugar, and sometimes milk. It swells three to four times its volume when mixed with cold water. The traditional production of garri is a long and tedious process. Five distinct operations are required: peeling, grating, fermentation and pressing, sieving, frying and drying These operations are traditionally carried out entirely by women, usually starting very early in the morning harvesting, peeling and washing the roots in the field, then carrying the cleaned roots to the village where the rest of the operations are carried out.

Grating

The grating operation is usually carried out manually, but power-operated graters of various makes and models are being more widely used Traditional method. Hand grating is invariably considered the most tedious and painful operation of the whole process. The women who still grate the cassava manually, when asked about the problems of garri processing, will simply show the palms of their hands. To hand grate one tonne of fresh peeled cassava roots generally requires 10-15 man days of effort (Cock 1985).

The cassava is usually grated at least one hour after washing in order that excess water can drain off the peeled and washed cassava, otherwise the roots are too slippery and too difficult hold during grating.

The manual grater is usually only a piece of galvanized metal sheet or even a piece of flattened can or tin, punched with about 3mm diameter nails leaving a raised jagged flange on the underside. This grating surface is fixed on a wooden frame and the cassava pieces are pressed against the jagged side of the metal and rubbed vigorously with strong downward movements. Particular care has to be taken and some skill is required "not to also grate the fingers" but still accidents sometimes happen. This traditional technology can be improved by mounting the grating surface on a wooden table at a convenient height so the rubbing action is horizontal rather than in a downward slant when the grating surface is supported against the operators legs It is not possible to completely grate a whole cassava piece, 3% to 5% of the cassava has to be left ungrated (Flach 1990, Bencini 1991). A skilful person is able to produce only about 20 kg/hour.

Mechanized Grating

Sometimes a group of processors will purchase their own mechanically powered rasping or grating machine or a private contractor will travel within a group of villages grating cassava for a fee. There are two types in common use: [i] modified hammer mills and [ii] graters using an abrasive disc. The abrasive surface can be either cylindrical or a flat disc and is frequently a galvanized metal sheet with nail-punched holes, as in the hand grater, and attached to a wooden frame. It is said the grating surface normally wears out with six months of regular use and must be replaced otherwise the output of the machine is significantly reduced. One further disadvantage with this rudimentary grating surface is the difficulty of cleaning it after use. Debris becomes lodged in the holes and within the torn flanges and becomes a substrate for microbial growth and the possible subsequent contamination of the grated cassava which could affect the subsequent fermentation.

Eco-Innovation

Eco-innovation has become one of the important strategic tools to obtain sustainable developments in manufacturing industries because of the increasing environmental pressure. In the past, investing in environmental activities was considered as unnecessary However, strict environmental regulations and popular environmentalist have changed the competitive rules and patterns for companies.

With the emerging importance of eco-innovation since the late 1990s, researchers have addressed eco-innovation from different perspectives. First are those studies that identify factors that drive eco-innovation and the performance outcomes arising from eco-innovation, with Kammerer (2009) and Dangelico and Pujari (2010) being the more recent examples of this category. Second are those that identify the dimensions of eco-innovation, with Hermosilla et al. (2010) as one recent article in this category. Third group of studies is related with the measurement of eco-innovation (e.g., Arundel and Kemp, 2009); Cheng and Shiu, 2012). Kemp and Pearson (2008) define eco-innovation as the production, assimilation or exploitation of a product, production process, service or management or business methods that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives. Similarly, Jin et al. (2008) suggest that it involves both introduction of a good/service that is new or significantly improved and decreases negative impacts on the environment. The goal of eco-innovation is to systematically align sustainability initiatives within a company's strategy and implement this strategy throughout the supply chain, from new product and service development to consumption (Jone et al., 2008). Eco- innovation (green innovation) can be classified into three main categories: eco-product innovation, eco-process innovation and green managerial innovation. The most common usage of the term "eco-innovation" is to refer to innovative products and processes that reduce environmental impacts. This is often used in conjunction with eco-efficiency and eco-design. Leaders in many industries have been developing innovative technologies in order to work towards sustainability. However, these are not always practical, or enforced by policy and legislation

Design Considerations

Constructing the mobile cassava grater, bearing in mind the kind of operation efficiency with a minimized cost they include; materials selection: this was the first design feature considered all the component parts of the machine in contact with the cassava tuber were made of stainless steel materials because of its anti-rust property the pulley was made of aluminium material for easy machineability and to reduce weight the wooden drum was covered with stainless sheet as shown in Fig 8; before being wound with the grating surface to avoid the direct contact of moisture with the wooden drum which will cause its decay the choice of v-belt was made to transmit power generated from the prime mover to the rotating drum because it requires small amount of installation work, absorbs shock and operates at low bearing pressure as well as being used widely in power transmission shown in fig:5.

Vibration Control

Considering the operation of the machine, an attached base stand helps to withstand the vibrations generated during the operation of the machine and for support also.

Maintenance

Maintenance was not neglected during the design considerations and as such the design was made in such a way that the machine could be detached into its various component parts to allow for maintenance in case of breakdown. Shown in fig:1-13 the components.

Cost: The mobile cassava grater was designed to stand better substitutes to existing ones and design was chosen for reliabilities.

1. Long product development,
2. Countless trial and error,

3. Accountability.
4. Limited Profitability.

The cost of machine of this type could be high when produced under small scale production. But the other advantages are that it does not require any specialist skill for its operation and it does not call for any elaborate production environment before it becomes operational and so many others. The advantages of this design outweigh the disadvantages. In fact it can be used where mass production is necessary with high efficiency.

Description of Machine Parts

The Main Frame: The main frame will be constructed with angle iron. The angle iron are welded together to form the frame work. The welding provides very rigid joints. This is in line with the modern trend of providing rigid frames. This provides the strength and rigidity for the overall machine. 2.5 ″ by 2.5 ″ angle bars was used as shown in see fig 1.

The Hopper: The hopper i s the receptacle through which cassava is admitted into the machine for grating. It has a rectangular plan which the tapers gradually. Volume of the hopper = [½ (a + b) H]L = 23m 3**.** Shown in fig; 7.

The Grating Unit: This unit consists of the shaft, perforated mesh, rolled sheet, circular discs rivet pins. The drum will be formed by the shaft passing through the rolled cylindrical sheet and it will be welded in place by circular discs. This drum is then wrapped with the perforated mesh, they are attached by riveting as illustrated in fig: 10.

Prime mover and Pulley System: A prime mover is used to power the machine. A reduction pulley system is used to transmit power to the grater's drum at reduced speed and increased torque. This enables the drum to exhibit rotary motion thereby grating the cassava. Shown in fig; 2

The Discharge Unit: This is a continuation of the grater's frame connected to the hopper. It directs the flow of the grated cassava to a storage pit or receptacle. Shown in fig: 11.

V-Belt was made to transmit power generated from the prime mover to the rotating drum because it requires small amount of installation work Shown in fig: 5.

Bearing: It exists as a standard component, it is of various types- cone bearing, roller, knuckle bearing and from steels-chromium steel. Among these types mention above, some are sealed while some are not. For our design, we opt for the knuckle bearing with sealed ball bearing to avoid grease contamination on the machine.. The selection of knuckle bearing is that it balances itself and possesses the required hardness and toughness. Shown in fig 3

Modeling Of Machine and the Components

Figure: 1 The frame

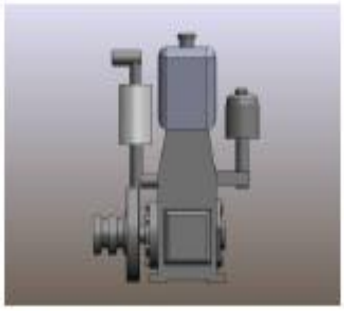


Figure: 2 Prime mover

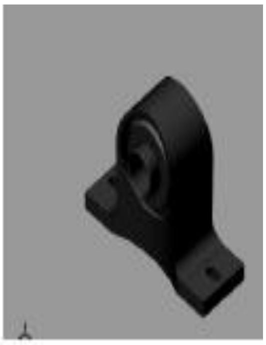


Figure 3 :Bearing

Figure :4 A set of pulley

Figure:5 V-Belt

Figure.6 wheel

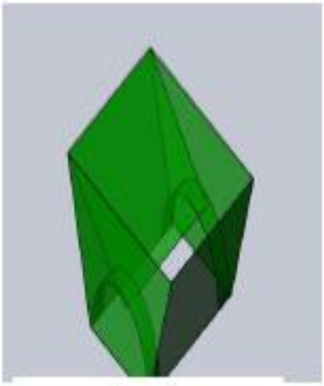


Figure:7 Hoper

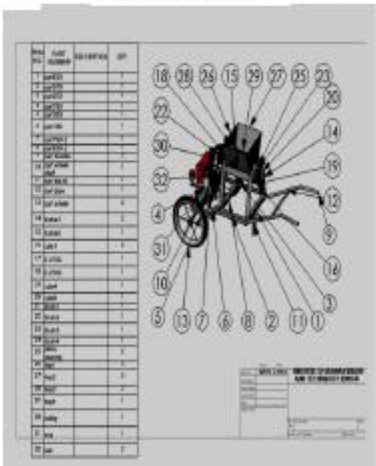
Figure8: Perforated mesh

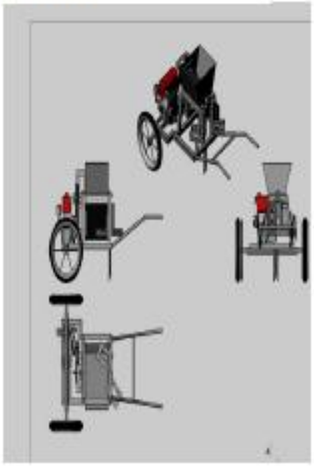
Figure ;9 ;inserted wood

Figure:10 Grater Unit

Figure; 11 outlet

Figure 12 handle





Simulation of the Components

Fig 16 shaft

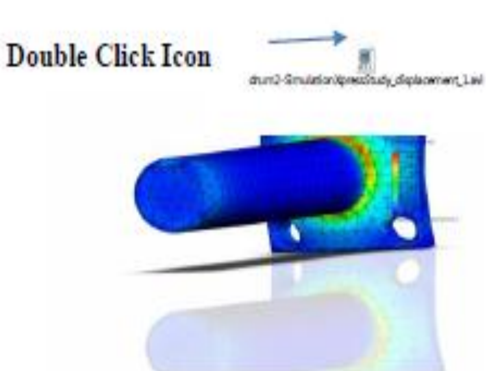


Figure ;17 shaft under stress

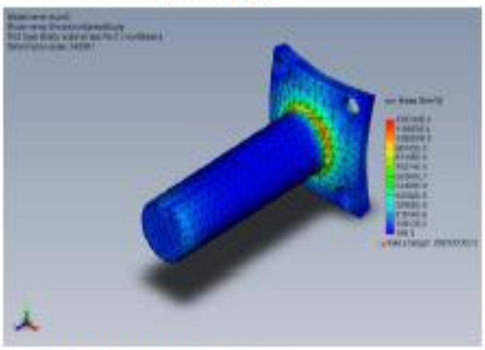


Figure 18 deformed shape

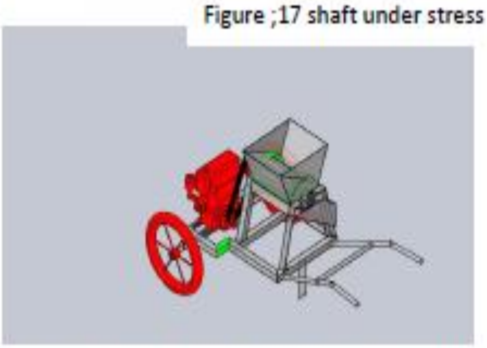
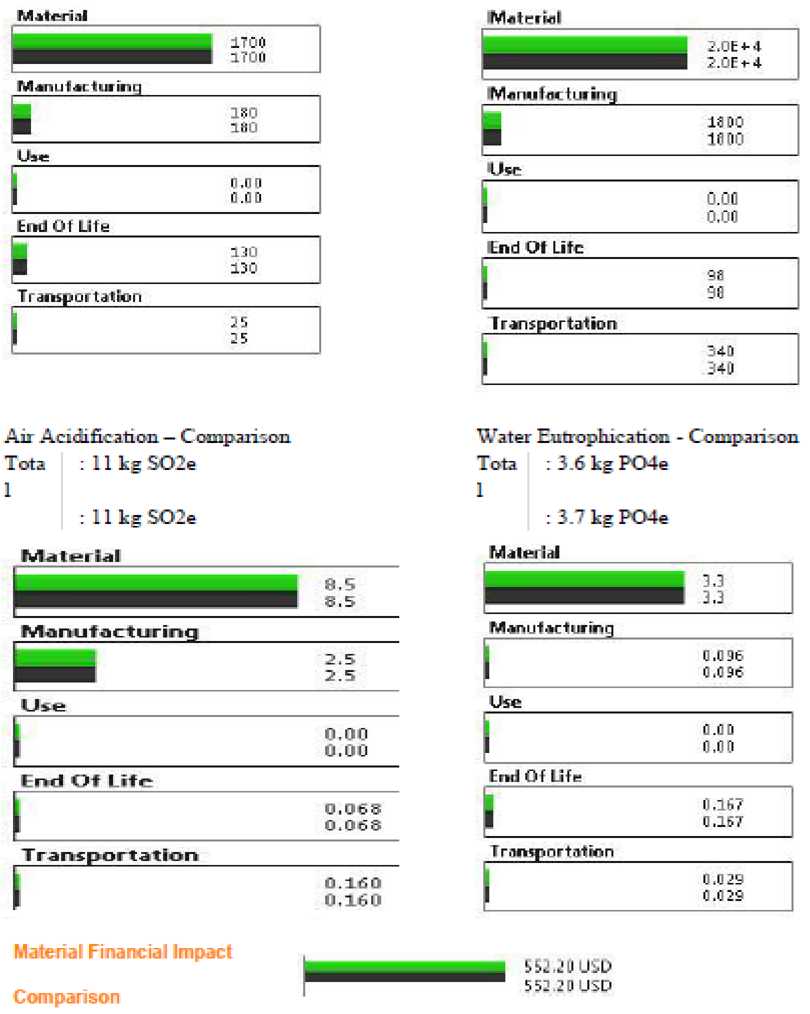


Figure ;19 Sustaniblity analysis of the machine

Table 1: Component Environmental Top Ten Components Contributing Most to the Four Areas of Environmental Impact.

Component	Carbon	Water	Air	Energy
eng	810	0.187	5.6	9900
part wheel	46	0.158	0.761	230
belt	44	0.020	1.1	420
cute4	18	0.060	0.095	190
pulley	52	0.012	0.362	640
part wheel shaft	33	0.025	0.192	390
drum2	9.9	0.033	0.051	110
hop4	9.7	0.032	0.050	100
hop2	9.1	0.030	0.047	97
hop1	8.3	0.027	0.043	88

Table 2: Sustainability Report.



Design Process

Engineers use CAD to create two− and three−dimensional drawings, such as those for automobile and airplane parts, floor plans, and maps and machine assembly. While it may be faster for an engineer to create an initial drawing by hand, it is much more efficient to change and adjust drawings by computer. In the design stage, drafting and computer graphics techniques are combined to produce models of different machines. Using a computer to perform the six step ‘art to part’ process: The first two steps in this process are the use of sketching software to capture the initial design ideas and to produce accurate engineering drawings. The third step is rendering an accurate image of what the part will look like. Next, engineers use analysis software to ensure that the part is strong enough as shown in fig; 16-18 Step five is the production of a prototype, or model.

Modelling

Modeling is the process of producing a model; a model is a representation of the construction and of interest A model is similar to but simpler then the system it represent. One purpose of a model is to enable the analyst to predict the effect of change to the system. On the other hand, a model should be a close approximation to the real system and incorporate most of its salient features shown Fig;13. On the other hand, it should not be so complex that it is impossible to understand and experiment with it. A good model is a judicious tradeoff between realism and simplicity. In the final step the CAM software controls that the part. During the design of the machine, the drafting software was used (see the final drawing fig 13, detail drawing fig 14 and multiply views fig 15).

Simulation

Simulation technology can provide a highly effective means for evaluating the design of a new manufacturing system or proposed modifications to existing systems. This technology can be especially useful in supporting agility, sustainability, supply chain integration, as well as the development of new advanced processes. Manufacturing simulations are often used as measurement tools that predict the behavior and performance of systems that have not yet been implemented, or to determine theoretical capabilities of existing systems. Simulations are essentially experiments. As defined in Jerry Banks Handbook of Simulation, a simulation is: “the imitation of the operation of a real-world process or system over time. Simulation involves the generation of an artificial history of the system and the observation of that artificial history to draw inferences concerning the operational characteristics of the real system that is represented. Simulation is an indispensable problem-solving methodology for the solution of many real-world problems. Simulation is used to describe and analyze the behavior of a system, ask what-if questions about the real system, and aid in the design of real systems. Both existing and conceptual systems can be modeled with simulation." shown in figure 16-18.

Sustainability

Simulation technology has been a significant tool for improving manufacturing operations in the past; but its focus has been on lowering costs, improving productivity and quality, and reducing time to market for new products. Sustainable manufacturing includes the integration of processes, decision-making and the environmental concerns of an active industrial system to achieve economic growth, without destroying precious resources or the environment. Sustainability applies to the entire life cycle of a product shown in figure: 19. It involves selection of materials, extraction of those materials, of parts, assembly methods, retailing, product use, recycling, recovery, and disposal will need to occur if simulation is to be applied successfully to sustainability. Manufacturers will need to focus on issues that they have not been concerned with before, for detailed information check table 1&2 and fig: 19 sustainability analysis, component environmental impact and environmental impact comparison.

RECOMMENDATION/CONCLUSION

We recommend that the movable parts be oiled properly before usage. That the machine must be properly Installed, balanced before usage to withstand the vibration involved. The pulley, belt and the wheels should be inspected before usage. The machine must be properly cleaned after the normal daily work to be free from attack the parts of the machine. The combination of human creativity with computer technology provides the design efficiency that has made CAD such as popular design tool. CAD has allowed the designer to bypass much of the normal drafting and analysis that was previously required, making the design process flow more smoothly. The social pillar associated with eco-innovation introduces a governance component that makes eco-innovation a more integrated tool for sustainable. In fact, software design should be encouraged in our institution of higher learning base on the following facts, long product development, countless trial and error, and accountability and limited profitability. Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange The Danish government's 2007 white paper on design.

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REFERENCE

1. Adetunji O.R and A. H. Quadri Design and fabrication of improved cassava grater Proceedings of the 1997 winter simulation conference ed. S. Andradottir, K, J. Healy. D. H. withers, and B. I. Nelson, 2011.
2. Agbetoye, L. A. S Engineering challenges in developing indigenous machinery for cassava production and processing. proceedings of annual conference of Nigeria Society of Engineers, 2003; 80-89.
3. Anon, 2004, "World Food programme" http;//www.fao.com.paper presented at international Starch Convention,11-14june 2002 Cracow, Poland, 2, April, 2008.
4. Akinlo, E. A. Improving the Performance of the Nigerian Manufacturing Sub-Sector after Adjustment, The Nigerian Journal of Economic and Social Studies, Page 9. Candace Carlson (2010) Improving Productivity in Mold Design and Fabrication, 1996.
5. Amber Beck, Nick Dalbec, James Zoss Design of a manually operated mixing Machine for Shea Butter application, 2005.
6. Bamiro, O. A. Paper presented at the AERC International conference on Acceleratin Africas Development Five years into the 21st century held in Tunis, Tunisia, 2006; 22-24.
7. Babyak, Rechard J. Visionary Design. Appliance Manufacture, 2003.
8. Bencini. M. C." POST-Harvest and Processing technologies of African Staples Foods A Technical compendium", Agricuture services Bulletin No.89.food and Agricultural organization (FAO Rome, Italy, 1991.
9. Charles Mcleam Manufacturing Simulation;. The need for Standard Methodologies, Model, and Data Interfaces, 2009.
10. Chime, Ukwuaba etal (2013) Design, Modelling Simulation and Fabrication of Screw Press Palm kernel oil expeller Proceedings of the2013 NSE International Conference Abuja, Nigeria
11. Chime, Ukwuaba, et al Improving Productivity In Feed Mixing Machine Manufacturing In Nigeria Published By Ijser Volume6,Issue 10, Octomber 2015 edition www.ijser.org, 2015.

12. Chime, Ukwuaba, et al Design, Modelling And Simulation Of A Palm Kernel Oil Extraction Machine Management Aproach published by IJOART 4, Edition http://www.ijoart.org/research-paper- publishing_october-2015.shtml, 2015.
13. Chime, Ukwuaba, et al Imroving Productivity In Hollow Impeller Palm Nut Cracking Machine Manufacturing In Nigeria *(*IMECE2015-53978) ASME Congress, 2015.
14. Chime. Ukwuaba et al Design Modeling and Simulation of Block Moulding Machine : Management Approach published by Int. Journal of Engineering Research and Applications www.ijera.com ISSN: 2248-9622, 2016; 6(4): 44-52.
15. Chime, Ukwuaba et al, *Design* Modeling, Simulation And Analysis Compress Spring International Journal of Engineering Science and Innovative http://www.ijesit.com Jan 2016 edition, 2015.
16. Cruz S. R, The mechanical cassava peeling machine. Araneta Journal of Agricuture, 1975. 184-18.
17. Delta Youth farmers multipurpose Co-operative Society ltd, proceeding of the workshop on cassava processing and its Socio –Economic benefits Warri, 2002.
18. Dr. Michael Grieve. Dual Manufacturing Both Real and Virtual Products, NASA MSFC/ University of Low, 2009.
19. Flach. M. gari processing in the north-West province of Cameroon Working document No.5.FAO Project CMR/86/017: Rome, Italy, 1990.
20. Bulent Sezen, Sibel Yildiz Cankaya Effects of green manufacturing and eco-innovation on sustainability performance Published by Elsevier Ltd. Selection and peer-review under responsibility of the International Strategic Management Conference www.sciencedirect.com FAO, 2000.
21. Cassava: An Essential part of Diet championing the cause of Cassava Http://www.fao.org/NEWS/2000/000405-e.htm., 2013.
22. FAO.2002. “FAOSTAT. Statistical Data Base of the food and Agricultural Organization (FAO) of the United Nations “FAO; Rome, Italy
23. FAO. FAO/GIEWS-food outlook no3”June product profile on cassava, 2001; 9.
24. Igbeka, J. C, Jory, N, and Griffon, D. Selective mechanization for cassava proceesing. Journal of Agriculture Mechanization in Asia and latin America, 1992; 23(1): 45-50.
25. IITA Research Highlights International of Tropical Agriculture, Ibadan, Nigeria Investment potentials in PRODA, 1979.
26. Kolawole. P. O, Agbetoye L.S.A and ogunlowo. S. A Sustaining Word Food security with Improved Cassava Technology. The Nigerian Experience. Mill project Report

Submitted to the Dept of Agricultural Engineering. Fed. College of Agriculture, Ibadan, https://en.wikipedia.org/wiki/Eco-innovation, 2010; 1-5.

27. Law, A. M., and M. G. Mc Comas. Secrets of Successful Simulation Studies, Proceedings of the Winter Simulation Conference, ed. J. M, 1991.
28. The Emerging Theory of Manufacturing Peter F. Drucker From the May–June Issue https://en.wikipedia.org/wiki/Eco-innovation, 1990.
29. Chime .O Thompson, Inyiama Fidelis Chidozie and Okonkwo Gloria Ngozi Design Innovation, Modelling And Simulation: Sustainability of Analysis of Bench Reactor for Kinetic Study of Hydro Carbon Removal using Land Farming published by International Journal of Engineering Technology and Computer Research (IJETCR) Available Online at www.ijetcr.org, 2016.
30. Ministry of Food and Agricural (MOFA), Annual sample Survey of Agriculture Ghana, 2003.
31. Needs Nigeria meeting every ones Needs Ngerhovwo J. T. cassava and the future of starch, Electronic Journal of Biotechnology, 2004; 7(1).
32. Ukwu Design and Fabrication of Mobile Cassava Grater (project submitted to Nigerian Society of Engineers professional exam, 2011.
33. Nweke. F. I. DIXON. A. G. O. Asieda, A and Fokayan. S. A cassava varietals needs of farmers and the potential for production growth in African, 1994; 32: 89-90.
34. Nweke F.I. processing potential for cassava production growth in Sub Sahara Africa COSA Workshop paper No.11, Collaborative Study of IITA Nigeri, 1994.
35. Odigbo, E. U. a cassava peeling machine development, design and Construction Journal of agricultural Engineering Research, 1976; 184-186.
36. Odigboh, E. U. Cassava Production. processing and utilization. Handbook of tropical foods. Marcel Dekker, Inc, 1976; 145.
37. Productivity in Nigeria, Proceedings of a National Conference, Edited by Osoba, A. M., 75.
38. Project management for small business made easy / by Sid Kemp. p. cm. ISBN 1-932531-77-7 (alk. paper).
39. Sriroth G. H. and Peterson R. k. World food programme on Cassava Production": ww. fao.co, 2000.
40. Bulent Sezen, Sibel Yildiz Cankaya Effects of green manufacturing and eco-innovation on sustainability performance, 2013.

41. Published by Elsevier Ltd. Selection and peer-review under responsibility of the International Strategic Management Conference www.sciencedirect.com.
42. R. Van Lee, L. Fabish, and N. Mc Gaw, “The Value of Corporate Values,” strategy business, Summer.
43. Advance manufacturing process Scientific Equipment Development Training Institute SEDI-E Enugu