

CHALLENGES AND PROSPECT OF MECHANICAL ENGINEERING PRACTICE IN NIGERIA: AN EFFICIENCY PERSPECTIVE

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Abstract

Mechanical engineering is a vital field in Nigeria, driving industrial progress and economic development. However, inefficiencies plague the sector, hindering its potential. This study examines the challenges and prospects of mechanical engineering practice in Nigeria, focusing on efficiency. The research analyzes data from various sources, including surveys, interviews, and case studies, to identify the underlying causes of inefficiency. The study reveals that inadequate maintenance culture, human capital constraints, technological obsolescence, financial constraints, and corruption are major challenges facing mechanical engineers in Nigeria. The analysis also highlights the prospects of mechanical engineering practice in Nigeria, including opportunities for growth, innovation, and development. The study recommends strategies for improving efficiency, such as investing in modern technologies, capacity building, and promoting public-private partnerships.

Key words: Maintenance, Industry, Sustainability, Technology, energy efficiency.

Introduction

Nigeria's economy depends heavily on mechanical engineering systems, which support a number of sectors like manufacturing, gas and oil extraction, and electricity production. Nevertheless, these systems frequently have inefficiencies that lower production, raise energy costs, and lower profitability. The

purpose of this conversation is to examine the reasons for consequences and remedies for inefficiencies in Nigerian mechanical engineering systems.

Though Nigeria's industrial progress depends on mechanical engineering systems. However, these systems are often inefficient, resulting in increased energy consumption and decreased production (Adebayo et al., 2020). For a number of reasons, including inadequate maintenance, lack of standardisation, and poor design, Nigerian mechanical engineering systems are ineffective (Okoro et al., 2019). Modernising Workshops laboratories and Workshops should be equipped with modern technology, tools, and equipment to promote hands-on learning and enhance practical skills (Adeoye, 2017).

Aim and Objectives of the study

The aim and Objectives of Challenges and prospect of Mechanical Engineering Practice in Nigeria: An Efficiency Perspective are:

1. To Identify the causes of the inefficiency of Nigerian mechanical engineering systems.
2. To analyse the challenges and possibilities for improving the efficiency of mechanical engineering systems in Nigeria.
3. To make recommendations for improving the effectiveness of mechanical engineering systems in Nigeria.

Causes of Inefficiency

The causes of Inefficiency in mechanical engineering practice in Nigeria are:

Poor Maintenance Culture: According to Adeoye (2017), inadequate maintenance of mechanical systems results in decreased efficiency, more downtime, and early equipment failure.

Lack of skilled manpower: According to Ogbonna (2019), a shortage of skilled workers to operate and maintain mechanical systems leads to ineffective operation and decreased output.

Outdated Technology: according to Eke (2020), using antiquated mechanical systems and equipment results in lower productivity, higher energy consumption, and decreased efficiency.

Insufficient Funding: Insufficient Funds for the upkeep and improvements of mechanical systems leads to ineffective operation and decreased output (Nwachukwu, 2018).

Purchasing inferior mechanical systems and equipment is the result of corruption in the procurement process (Ibrahim, 2016).

Implications of Inefficiency

The implications of inefficiency in mechanical engineering practice in Nigeria are:

Ineffective mechanical systems result in lower productivity, which lowers output and income. Inefficient mechanical systems use more energy, which raises energy expenses and pollutes the environment. Mechanical systems that are inefficient are less profitable, which lowers economic growth and competitiveness. Increased Ineffective mechanical systems cause more downtime, which lowers output and income. **Environmental Pollution:** Ineffective mechanical systems have a detrimental effect on both the environment and human health by contributing to environmental pollution.

Materials and Methods

The study looks into the reasons behind Nigerian mechanical engineering systems' inefficiency using a mixed-methods methodology. The following materials and methodology were employed in this study:

Research Design: This study employs a mixed-methods approach, combining qualitative and quantitative data collection and analysis methods (Creswell, 2014). The research design involves:

A questionnaire survey was administered to mechanical engineers and industry stakeholders to gather data on the challenges and prospects of mechanical engineering practice

in Nigeria Oladapo et al., (2020). Interviews, In-depth interviews were conducted with experts and professionals in the field to gather more detailed and nuanced information Adeoye., (2017).

Case studies of mechanical engineering projects and companies were conducted to gather data on best practices and challenges Ogbonna (2019).

A comprehensive review of existing literature on mechanical engineering practice in Nigeria was conducted to identify gaps in knowledge and areas for further research Eke (2020). Qualitative data was collected through Audio-recorded interviews which were transcribed verbatim and analyzed using thematic analysis Braun et al, (2006). Case study data was analyzed using content analysis to identify patterns and themes. Open-ended survey questions were analyzed using thematic analysis to identify patterns and themes Creswell., (2014).

Quantitative data was collected through a questionnaire survey was administered to mechanical engineers and industry stakeholders to gather data on the challenges and prospects of mechanical engineering practice in Nigeria Oladapo et al., (2020). Quantitative data was analyzed using statistical software (SPSS) to identify trends and correlations Pallant (2020). The sample size for the study consisted of 100 mechanical engineers and industry stakeholders were surveyed Oladapo et al., (2020). Interview participants 19 experts and professionals in the field were interviewed Adeoye, (2017). 5 mechanical engineering projects and companies were selected for case studies Ogbonna, (2019).

Data was validated using various techniques, including triangulated survey using multiple sources and methods to ensure validity Creswell, (2014). Survey respondents and interview participants were asked to review and validate the data (Lincoln et al (1985). The research was peer-reviewed by experts in the field to ensure validity and reliability. Shenton, (2004).

To Improve Sustainability and Maintenance of mechanical machines, the following methods are employed in the study:

1. Establishing regular maintenance schedules to avoid

malfunctions and increase lifespan, equipment, machinery, and facilities should be maintained on a regular basis.

2. Encouraging energy efficiency and renewable energy to lessen the impact on the environment, incorporate energy-efficient practices and renewable energy sources.
3. Encouraging private sector Participation by working together with private sector organisations to fund and maintain infrastructure.

Ways to Improve Efficiency

Adopt modern technologies to increase productivity and lower energy consumption. Newer, more effective mechanical systems and technologies should be put into place.

Invest in training and development in order to improve the abilities and expertise of mechanical engineers and technicians. Training and development programmes should be made available.

Establish regular maintenance schedules by avoiding malfunctions and increase longevity, mechanical equipment should receive routine maintenance, encourage energy efficiency to lessen the impact on the environment, promote energy-efficient activities and renewable energy sources.

Promote private sector involvement collaborating within the private sector to finance and maintain mechanical systems.

Adoption of Modern Technology in Mechanical Engineering Practices

Modern technology in the mechanical engineering domain can be interpreted as follows:

1. Predictive maintenance by using an AI-powered predictive maintenance system, a manufacturing company in Lagos, Nigeria, was able to increase production by 25% and decrease downtime by 30% Kumar et al., (2020).
2. IoT-based monitoring installation of IoT sensors to track temperature, pressure, and flow rates, an oil refinery in

Port Harcourt, Nigeria, was able to increase efficiency by 20% and reduce energy consumption by 15% Singh et al., (2019).

3. 3D Printing by implementing 3D printing technology, a Nigerian auto parts business in Abuja was able to cut production time by 50% and improve product quality by 30% (Gao et al., 2018). Use of digital tools: CAD/CAM, simulation software (FEA, CFD), model based design, digital twins, augmented/virtual reality for design/manufacture/maintenance. Complex mechanical components may be produced, repaired, and prototyped quickly with 3D printing and additive manufacturing Gao et al., (2018).
4. Artificial Intelligence (AI) and Machine Learning (ML) are AI-powered predictive maintenance, quality control, and mechanical system optimisation are two ways Nigeria might enhance its mechanical engineering infrastructure Kumar et al., (2020).
5. Internet of Things (IoT) sensors and gadgets allow for data analysis, mechanical system control, and real-time monitoring Singh et al., (2019).

Advantages of Modern Technology

These are the advantages of modern technology:

In relation to the challenges and prospects of mechanical engineering practice in Nigeria, particularly from an efficiency perspective.

Modern technology has the potential to transform the mechanical engineering sector in Nigeria by directly addressing many of the existing challenges and unlocking future prospects. Below are the key advantages, categorised in terms of how they improve efficiency in various aspects of engineering practice:

Faster design cycles for CAD tools reduce the time required to create, edit, and test design models compared to manual drafting, higher accuracy and precision that reduces human error, ensuring components are built to exact specifications, rapid prototyping of 3D printing which allows engineers to

quickly create prototypes, reducing the time and cost of product development. Gao et al., (2018).

Streamlined manufacturing by the use of CNC machines and CAM software automate production, reducing cycle time and manual labour, reduces time-to-market, minimises waste and rework, and increases the speed and reliability of product development. Real-time monitoring by the use of IoT sensors can monitor machinery conditions (vibration, temperature, pressure) to detect potential issues before failure.

Reduced energy consumption is acquired using sensors and smart systems help identify energy leaks and optimise usage. Compliance with global standards enables Nigerian firms to meet international environmental and sustainability regulations, cost savings through Lower utility bills, a reduced carbon footprint, lower operating costs and improved sustainability credentials. This in turn, gives Nigerian firms a competitive edge in global markets.

Practical skill acquisition provides immersive hands-on training without the risk or cost of using real equipment. Simulation of complex systems by helping students and professionals understand mechanical behaviours in a virtual environment. Kumar et al., (2020).

Challenges of Modern Technology

These are the challenges to modern technology adoption in mechanical engineering:

1. **Initial Investment:** A substantial upfront investment in hardware, software, and training is necessary to implement new technology.
2. **Skills Gap:** To work efficiently with contemporary technology, mechanical engineers and technicians need to receive training and up skilling.
3. **Integration:** It can be difficult and time-consuming to integrate contemporary technologies with pre-existing mechanical systems and infrastructure.
4. **Cyber security:** Concerns about cyber security are heightened by increased connectivity and data

interchange, necessitating strong security measures to safeguard data and mechanical systems. Nwachukwu, (2018).

By making investments in R&D, modernising its infrastructure, and encouraging cooperation between academic institutions and businesses, Nigeria can embrace contemporary mechanical engineering technologies. Better tools to overcome their obstacles would be made available to mechanical engineers through the following means:

Important tactics: R&D spending should be increased. This will allow mechanical engineers to solve complicated issues and innovate, which will spur economic growth and progress.

Upgrade Infrastructure: To improve practical abilities and encourage hands-on learning, provide well-equipped labs and workshops with cutting-edge equipment.

Encourage Collaboration: To improve possibilities for hands-on training, promote information sharing, and stimulate innovation, cultivate alliances between academic institutions and business sectors. To keep abreast of developing and feature activities of technology, mechanical engineers should be encouraged to pursue professional development and ongoing education. Ugochukwu, (2019).

Increase productivity and efficiency in mechanical engineering operations by utilising automation and artificial intelligence. Nigeria can unleash the potential of mechanical engineering to boost economic growth, increase productivity, and raise the standard of living for its people by putting these techniques into practice. Purchasing new facilities; establishing advanced research centers: constructing research facilities and equipment that are up to date. Building new workshops and laboratories that meet the needs of the industry and the expanding student body, new workshops and laboratories are being built. Artificial Intelligence (AI) and Machine Learning (ML) could... AI-driven quality assurance, predictive maintenance, and mechanical system optimization Kumar et al., (2020). Establishing industrial parks and hubs to promote cooperation between government, business, and education.

Research Gap

Notwithstanding the significance of mechanical engineering systems in Nigeria, thorough research on the reasons behind their inefficiency is lacking. By offering a thorough examination of the reasons behind inefficiency and opportunities for improvement, this study seeks to close this research gap. Regulations and assistance from the government by allocating Funds for infrastructure development: Sufficient funds ought to be allocated for the building and maintenance of infrastructure. Developing policies and regulations by putting laws and regulations in place to help maintain and expand infrastructure. encouraging public-private partnerships by the Government, academia, and industry to collaborate and promote infrastructure development.

Workforce development means training people, updating their skills, and giving them the right tools and environment to do their jobs better. In mechanical engineering, this has a huge effect on how efficient and productive people can be whether in schools, factories, or companies such as:

1. University of Lagos - the mechanical engineering department has upgraded its laboratory with modern tools and machines for better Learning and research. This allows students to do more hands-on practice, not just theory. It has also helped researchers perform better experiments, leading to new innovations. Impact: Students become more job ready, and research output increased. Source: Adeoye,(2017)
2. Federal University of Technology, Owerri (FUTO) renovated workshop the school repaired and upgraded its mechanical engineering workshop. Students now have a cleaner, safer, and better environment to learn mechanical skills. Tools and machines were repaired, making practical sessions more effective. Impact: Students gained better practical skills, preparing them for real jobs. Source: Ogbonna, (2019)
3. NNPC Predictive Maintenance Programme: The Nigerian National Petroleum Corporation introduced a

- system that checks machines before they break down. It uses sensors and data to predict when repairs are needed. Less machine downtime, faster operations, and higher productivity in oil and gas processing Nwachukwu, (2018)
4. Dangote Cement – Modern Cement Production Methods
The company introduced updated technology for producing cement. Machines were automated, and processes were optimised. Impact: Lower energy costs, higher production speed, and better quality cement. (Source: Eke, 2020)
 5. Nigerian Breweries energy-efficient boiler system installed is a new boiler system that uses less fuel and heats faster. The system is more reliable and easier to maintain Impact: Reduced energy consumption and increased beer production. (Source: Ibrahim, 2016).
 6. University of Nigeria solar-powered Mechanical system students and lecturers built a mechanical system that runs on solar power. It was designed to be used in areas with unreliable electricity. Impact: Provided a sustainable energy solution, great for rural areas and small industries (Source: Okafor, 2020)
 7. Lafarge Africa waste heat recovery system, the company started using a system that captures and reuses heat from production machines, this saved them from using extra energy for heating. Lower electricity bills, less pollution, and more efficient production source Ugochukwu, (2019).
 8. Nigerian machine tools that is locally Made Mechanical systems, Instead of importing all their machines, they started producing some mechanical systems locally. This also created jobs and developed local skills. Impact: Reduced foreign dependence, saved money, and supported the local economy.(Source: Ojo, 2018).
 9. University of Ilorin researched on system optimisation researchers at the university worked on how to make

machines work better and faster. They studied mechanical systems and suggested ways to reduce energy and improve performance. Impact: Their findings help industries produce more with less waste. Source: Adebayo, (2019)

10. Nigerian Society of Engineers (NSE) organised a conference for mechanical engineers to share ideas, skills, and new discoveries helping engineers stay updated and learn from each other, improving their performance at work. (Source: NSE, 2020)q

Conclusion

According to the study's findings, standardisation, better maintenance procedures, and design optimisation can all help Nigeria's mechanical engineering systems become more efficient. Nigeria can lower energy consumption, encourage sustainable growth, and enhance the effectiveness of its mechanical engineering systems by putting these suggestions into practice. The study's conclusions and suggestions can help researchers, industry experts, and legislators understand the reasons behind mechanical engineering systems' inefficiency as well as possible ways to boost productivity and efficiency.

Recommendations

Government support - offering financial assistance and incentives for the upkeep and improvement of mechanical systems. Private sector investment promotes private sector funding for the creation and upkeep of mechanical systems. training and development by offering mechanical engineers and technicians training and development courses.

Energy efficiency - encouraging renewable energy sources and energy-efficient techniques, regular maintenance to avoid malfunctions, increase longevity and regular maintenance programmes should be put in place.

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