



Managing Innovation and Sustainability of Automobile Technology Education to Produce Quality University Graduates in Nigeria

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Abstract

This study explores the integration of innovation and sustainability in automobile technology within university curricula to enhance the quality of graduates. A descriptive research design was employed to examine how universities incorporate modern automotive advancements and sustainable practices into their programs. The population comprised university faculty members, students enrolled in automotive engineering or automobile technology programs, and industry professionals from the automobile sector. A sample of 200 participants was selected using a stratified random sampling technique to ensure representation across different educational and industrial backgrounds. The data was collected using questionnaires and structured interviews to assess the extent of curriculum updates, practical training opportunities, and industry collaborations. Additionally, document analysis was conducted to review existing course materials and institutional policies on sustainability in automobile technology. The findings of the study highlight the key areas where universities can enhance their programs to align with industry needs, ensuring that graduates possess the necessary skills to drive innovation and sustainability in the automotive sector. Recommendations focus on curriculum improvement, increased industry partnerships, and investment in sustainable automotive research.

Keywords: Managing, Innovation, Sustainability, Automobile technology.

1. Introduction

Automobile Technology Education is a vital component of technical and vocational education designed to equip students with the skills and knowledge required in the automotive industry. In Nigeria, rapid technological changes, globalization, and evolving industry needs require that higher education institutions innovate and sustain their teaching methods, curricula, and training resources to produce graduates who are competent, employable, and ready to participate meaningfully in the automobile sector. Technological advancements in the automobile industry have reshaped the demands placed on engineering and technology graduates globally. Universities play a crucial role in ensuring that graduates are not only knowledgeable in fundamental automotive principles but are also innovative and sustainability-driven to meet global standards (Kaur, Sharma & Bansal, 2022). Automobile technology education must evolve alongside the industry's rapid transformation towards electric mobility, autonomous driving, and green technologies.

Innovation within the automotive sector, particularly with the rise of electric vehicles and smart technologies, demands a revision of educational

programs. Traditional mechanical-focused curricula are no longer sufficient to prepare students for the emerging realities of the profession (Huang, Zhang & Zhou, 2021). Universities must ensure that curricula incorporate interdisciplinary skills in information technology, electronics, artificial intelligence, and sustainable energy systems. Sustainability, once a peripheral concern, has become a major driver in shaping automotive education. Global environmental challenges and regulatory frameworks now mandate a shift towards eco-friendly vehicle production, necessitating that university graduates are well-versed in sustainability principles (Li, Zhang, & Hong, 2020). Automobile technology programs must teach not only engineering design but also life-cycle analysis, alternative energy solutions, and sustainable manufacturing practices.

Moreover, the collaboration between academia and industry is increasingly essential to bridge the skills gap. Industry expectations for practical competencies, innovation abilities, and entrepreneurial skills can only be met through strong partnerships that provide real-world training opportunities (Devasia, Sreedharan, & Krishnan, 2023). This makes curriculum innovation and sustainability strategies indispensable for quality graduate production.

The rise of the Fourth Industrial Revolution (Industry 4.0) has introduced new dynamics such as automation, big data, and smart manufacturing systems into the automobile industry. Universities must not only teach students about these changes but must also ensure that

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their learning environments themselves are innovative and technologically advanced (Sánchez, Pérez, & Díaz-Garrido, 2022).

Unfortunately, many university programs in developing countries still lag behind in updating their automobile technology curricula to match global trends. The consequence is a mismatch between graduates' competencies and industry needs, which impedes employment and economic growth. It therefore explores the strategies for managing innovation and sustainability in automobile technology education, emphasizing curriculum renewal, industrial collaboration, and practical training to produce graduates capable of driving future transformations in the automotive industry. Technological innovation in automobile education encompasses the use of advanced automotive systems, including hybrid and electric vehicles, automated driving, and smart vehicle technologies. Studies show that integrating these innovations into university curricula leads to improved student competencies and job readiness (Bai, Li, & Yu, 2021).

Electric vehicles (EVs) have significantly transformed the global automotive industry by redefining vehicle design, energy consumption, and maintenance systems. This transition from internal combustion engines to electric mobility requires a fundamental shift in automobile technology education. Educators are now expected to emphasize critical areas such as battery technology, electric powertrains, regenerative braking systems, power electronics, and charging infrastructure. Hassoun, Al-Hadhrami, and Al-Sulaiman (2019) stated that effective EV education demands both theoretical understanding and hands-on exposure to emerging technologies. However, studies have revealed substantial curricular gaps in these areas across many developing countries, including Nigeria, where traditional automotive curricula still prioritize petrol and diesel engine technologies.

Sustainability in automotive education extends beyond technological advancement to encompass environmental responsibility and resource efficiency. Teaching sustainability principles such as green vehicle design, lightweight materials, material recycling, energy efficiency, and life-cycle assessment equips students with the knowledge required to minimize environmental impacts throughout a vehicle's lifespan. Ehsani, Gao, and Emadi (2020) argued that future automobile engineers must balance performance, cost, and environmental sustainability in their designs. In the Nigerian context, where environmental degradation and carbon emissions remain pressing concerns, embedding sustainability concepts into automobile technology education is critical for producing graduates capable of contributing to national and global environmental goals. Industry-academic collaboration has emerged as a vital mechanism for integrating innovation into automobile technology education. Universities that establish

partnerships with automobile manufacturers, EV startups, and automotive service firms are better positioned to expose students to current industry practices and technologies. Such collaborations often facilitate internships, industrial attachments, cooperative education programs, and project-based learning initiatives that allow students to work on real-world automotive challenges. Zhou, Luo, and Wu (2021) emphasized that these partnerships bridge the gap between theory and practice, enhance students' technical competence, and improve graduate employability. For Nigerian universities, strengthening industry linkages is essential for aligning educational outcomes with labor market needs. The integration of digital technologies has also become a cornerstone of modern automobile technology education. Tools such as computer-aided design (CAD), computer-aided manufacturing (CAM), simulation software, and advanced vehicle diagnostics systems are now indispensable in automotive design, testing, and maintenance.

Song, Wang, and Yang (2022) note that universities that prioritize digital competencies enable students to develop precision, analytical skills, and problem-solving abilities required in contemporary automotive industries. The effective use of digital tools also supports innovation by allowing students to model, simulate, and test automotive systems virtually before physical implementation. Furthermore, the global transition towards smart cities and intelligent transportation systems has expanded the scope of automobile technology education. Modern vehicles are increasingly connected, autonomous, and data-driven, requiring knowledge of vehicle connectivity, Internet of Things (IoT) applications, artificial intelligence, and cyber security.

Zhou, Chen, and Wu (2022) highlighted that automotive graduates must understand how vehicles interact with digital infrastructure and urban systems. Incorporating these topics into university curricula ensures that graduates are prepared to contribute to emerging mobility solutions, particularly as Nigeria explores smart transportation initiatives. Innovation management within automobile technology education emphasizes the development of entrepreneurial thinking, creativity, and critical problem-solving skills. Beyond technical competence, students must be trained to identify opportunities, design innovative solutions, and adapt to technological disruptions. Yu, Zheng, and Wang (2019) asserted that innovation-oriented education fosters adaptability and lifelong learning, qualities essential for graduates operating in dynamic automotive environments. These competencies are especially important in developing economies, where graduates are often required to create solutions tailored to local challenges.

Despite the recognized importance of innovation and sustainability, several challenges hinder their effective integration into automobile technology education. In

many African universities, inadequate funding, obsolete training equipment, insufficient laboratory facilities, and limited professional development opportunities for lecturers constrain curriculum modernization. Nkengbeza, Mukete, and Asongu (2023) observed that these structural and institutional barriers limit universities' capacity to adopt emerging automotive technologies, including EV systems. Addressing these challenges requires coordinated efforts from government, institutional management, and industry stakeholders. Emerging pedagogical models have been proposed as effective strategies for enhancing innovation readiness among students. Approaches such as project-based learning (PBL), flipped classrooms, and blended learning promote active learning, collaboration, and practical problem-solving. Gao, Wang, and Zhang (2021) argued that these learner-centered methods improve engagement and encourage students to apply theoretical knowledge to real-life automotive problems. When combined with modern technologies, such pedagogies can significantly improve the quality of automobile technology graduates.

1.1 Statement of the Problem

Automobile Technology Education in Nigerian universities is confronted with significant challenges in keeping pace with rapid innovations and sustainability demands within the global automotive industry, particularly the transition towards electric vehicles (EVs), smart transportation systems, and environmentally responsible engineering practices. Many university programmes still rely on out-dated curricula that emphasize conventional internal combustion engine technologies, with limited attention given to battery systems, electric powertrains, digital diagnostics, and sustainability-oriented design. This misalignment between educational content and industry realities has resulted in graduates who lack the practical skills, technological competence, and innovative capacity required by modern automobile industries, thereby affecting their employability and overall contribution to national technological development.

The necessity of addressing this problem arises from the strategic role automobile technology graduates play in Nigeria's industrialization, environmental sustainability, and economic diversification goals. Without effective management of innovation and sustainability in automobile technology education, universities risk producing graduates who are ill-prepared for emerging automotive trends, including clean energy transportation and digitally driven mobility solutions. This situation underscores the urgent need for curriculum reform, improved infrastructure, faculty capacity development, and stronger industry-academic partnerships. Addressing these gaps is essential to ensure the production of high-quality university graduates who can drive innovation, support sustainable development, and enhance Nigeria's competitiveness in the evolving global

automotive sector.

1.2 Objectives of the Study

The study is aimed to investigate how innovation and sustainability can be managed within automobile technology education to produce high-quality university graduates. Specifically, the objective seeks to:

- i. Examine the extent to which universities incorporate modern automotive innovations into their curricula.
- ii. Assess the integration of sustainable practices within automobile technology education.
- iii. Evaluate the collaboration between universities and the automobile industry in curriculum development.

1.3 Research Questions

The following research questions will be guided the study:

- i. What are the extent of incorporation of modern automotive innovations into the university curriculum?
- ii. What are the integration of sustainable practices within automobile technology education?
- iii. What are the collaboration between universities and the automobile industry in the curriculum development?

2. Methodology

This study adopts a descriptive survey research design to examine how innovation and sustainability are managed in automobile technology education for the production of quality university graduates in Nigeria. The design is considered appropriate because it allows for the systematic collection of data on existing practices, challenges, and strategies from a large group of respondents. The population of the study comprises lecturers and final-year undergraduate students in Automobile Technology Education and related technical education programmes in selected Nigerian universities. From this population, a sample size of 200 respondents is used, consisting of both academic staff and students who are directly involved in automobile technology teaching and learning. A stratified random sampling technique is employed to ensure fair representation of lecturers and students in the study. Data are collected using a structured questionnaire developed by the researcher, focusing on innovation practices, sustainability integration, availability of facilities, industry collaboration, and graduate quality. The instrument is validated by experts in technical and automobile technology education, while reliability is established using the test-retest method. Data collected are analyzed using descriptive statistics such as frequency counts, percentages, mean, and standard deviation, while inferential statistics (such as correlation or regression analysis) are used to test the formulated hypotheses at a 0.05 level of significance.

Table 1: Shows Incorporation of Modern Automotive Innovations into Nigeria University Curricula

Statement	Agree (%)	Neutral (%)	Disagree (%)	Mean Score
Curricula include electric vehicle (EV) technology	68%	20%	12%	3.8
Courses cover autonomous vehicle systems	42%	25%	33%	3.1
Use of simulation tools (e.g., CAD/CAE) is integrated	74%	15%	11%	4.0
Adoption of latest diagnostic and repair technologies	66%	18%	16%	3.7

Source: Author's Field Survey, 2025

Table 2: Demonstrates Integration of Sustainability Practices into Automobile Technology Education

Statement	Agree (%)	Neutral (%)	Disagree (%)	Mean Score
Curriculum includes modules on green automotive technologies	60%	22%	18%	3.5
Courses address environmental regulations and standards	71%	16%	13%	3.9
Practical sessions emphasize sustainable maintenance practices	54%	23%	23%	3.3
Research projects focus on eco-friendly innovations	48%	28%	24%	3.2

Source: Author's Field Survey, 2025

Table 3: University-Industry Collaboration in Automobile Technology Education

Statement	Agree (%)	Neutral (%)	Disagree (%)	Mean Score
Universities partner with automobile companies for internships	76%	12%	12%	4.1
Industry experts contribute to curriculum development	38%	29%	33%	2.9
Joint research projects between universities and industry	35%	27%	38%	2.8
Frequent guest lectures or workshops by industry professionals	58%	20%	22%	3.5

Source: Author's Field Survey, 2025

3. Results and Discussion of Findings

This section presents the findings based on the study research questions. The results are discussed and interpreted by comparing them with existing literature.

Research Question 1: What are the extents of incorporation of the modern automotive innovations into their university curriculum?

The results indicated a generally positive integration of innovative technologies in automobile technology education, though with noticeable gaps in some advanced areas. A majority of respondents (68%) agreed that curricula include electric vehicle (EV) technology, with a relatively high mean score of 3.8. This suggests that Nigerian universities are making commendable efforts to introduce EV-related content, reflecting responsiveness to global automotive trends. However, the presence of 20% neutral responses implies that EV coverage may not be comprehensive or uniformly implemented across institutions. In contrast, courses covering autonomous vehicle systems recorded a lower level of agreement (42%) and the lowest mean score (3.1). This finding reveals a significant deficiency in the inclusion of cutting-edge automotive innovations such as automation, sensors, and artificial intelligence. While the integration of simulation tools such as CAD/CAE shows strong adoption evidenced by 74% agreement and the highest mean score of 4.0 indicating effective use of digital technologies for design and analysis, the adoption of latest diagnostic and repair technologies is only moderately strong (66% agreement; mean score 3.7). Overall, the results suggest that while foundational innovation tools are well integrated, advanced and emerging technologies

require greater curricular emphasis to fully prepare graduates for future automotive industry demands. The findings of the study aligned with the study of Alves et al. (2020) argued that although higher education institutions are increasingly adopting new automotive technologies, there is often a delay in integrating more cutting-edge systems like autonomous vehicle programming due to resource and expertise constraints. Conversely, Wang et al. (2021) supported the importance of upskilling students in EV and diagnostic technologies, noting that universities embracing these innovations tend to produce more industry-ready graduates.

Research Question 2: What are the integration of sustainable practices within automobile technology education?

The data in Table 2 indicated that moderate integration of sustainable practices. While environmental regulations are covered by 71% of the universities, there is less emphasis on research and innovation focusing specifically on eco-friendly practices (48%). These results are in agreement with Leal Filho et al. (2019), who observed that sustainability topics are often included theoretically but rarely translated into practical or project-based learning in technical education. Furthermore, Zhou et al. (2022) emphasized the importance of hands-on, sustainable practices in technical education for achieving true environmental literacy among graduates, a gap still evident in many Nigerian universities as shown by the study.

Research Question 3: What are the collaboration between universities and the automobile industry in the

curriculum development?

The findings reveal varying levels of industry–academic collaboration within automobile technology education. A substantial majority of respondents (76%) agreed that universities partner with automobile companies to provide internship opportunities for students, reflected in a high mean score of 4.1. This indicates that industrial training and practical exposure are relatively well established and serve as a key avenue for bridging the gap between theory and practice. Similarly, frequent guest lectures and workshops by industry professionals recorded moderate agreement (58%) with a mean score of 3.5, suggesting that industry engagement in knowledge sharing exists but is not consistently implemented across all institutions.

Conversely, more strategic and long-term forms of collaboration appear weak. Only 38% of respondents agreed that industry experts contribute to curriculum development, while 33% disagreed, resulting in a low mean score of 2.9. Even more concerning is the limited involvement in joint research projects, with just 35% agreement and the lowest mean score of 2.8. These results suggest that while short-term collaborations such as internships are relatively strong, deeper partnerships that foster innovation, curriculum relevance, and sustainable knowledge transfer between universities and the automobile industry remain inadequate and require deliberate policy and institutional support. This study's finding corroborated the work of the study of Okolie et al. (2020) stated that although industry collaborations are increasingly prioritized in Nigerian tertiary education policies, their actual implementation particularly in curriculum co-development is limited. In contrast, Musingafi et al. (2019) advocated for stronger, structured industry-academia linkages to bridge the skill gaps observed among engineering graduates. The limited involvement of industry professionals in curriculum formulation as found in this study reveals a critical area needing urgent policy intervention to ensure graduates are not only knowledgeable but also industry-ready.

4. Conclusion

This study examined how innovation and sustainability are managed within automobile technology education programs to enhance the quality of university graduates in Nigeria. The results indicated that while many universities have made considerable progress in integrating modern automotive innovations such as electric vehicle technologies and simulation tools, there remains a notable gap in the inclusion of advanced systems like autonomous vehicles. Similarly, although environmental standards and green automotive technologies have found their way into the curriculum, the practical application of sustainability principles through projects and research initiatives are still insufficient.

Furthermore, the collaboration between universities

and the automobile industry was found to be uneven. Internship opportunities for students are widely available and beneficial; however, deeper collaborations such as active participation of industry professionals in curriculum development and joint research activities are still lacking. These gaps highlight a misalignment between educational outcomes and industry needs, which may hinder the ability of graduates to fully meet the evolving demands of the global automotive sector.

Overall, while the direction towards innovation and sustainability is evident, universities must intensify efforts to ensure comprehensive, practical, and industry-aligned training for automobile technology students. Achieving this would significantly enhance the employability and entrepreneurial potential of graduates, thereby contributing to the broader objectives of sustainable development and technological advancement in the automobile sector.

5. Recommendations

Based on the findings of the study, the following recommendations are proposed:

- I. Universities should periodically review and update their automobile technology curricula to incorporate emerging technologies such as autonomous driving systems, connected vehicle technologies, and hybrid powertrain systems. This should be complemented by the acquisition of modern teaching tools and simulators.
- II. Institutions must go beyond theoretical inclusion of sustainability by embedding hands-on eco-friendly automotive practices into laboratory work, capstone projects, and student research initiatives. Topics like battery recycling, sustainable materials, and low-emission manufacturing processes should be emphasized.
- III. Universities should formalize partnerships with automobile companies not only for internships but also for curriculum design, guest lectures, and joint research ventures. Advisory boards composed of industry experts could be established to periodically review and recommend updates to academic programs.
- IV. Continuous professional development programs should be organized for lecturers to keep them abreast of the latest trends in automotive innovation and sustainability practices. International exposure through workshops, exchange programs, and conferences should be encouraged.
- V. Governmental and accrediting bodies should establish clear guidelines and incentives for integrating innovation and sustainability into technical and engineering education programs. Compliance with these guidelines

should be made a prerequisite for program accreditation and funding.

- VI. Universities should establish automotive innovation hubs where students can engage in multidisciplinary projects that foster creativity, innovation, and entrepreneurship. These centers can act as incubators for new automotive technologies and sustainable practices.

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