Technological Skill Improvement Needs of Automobile Engineering Graduates to Effectively Maintain Hybrid Vehicles in Nigeria

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Abstract- ***The study aimed to assess the technological skill improvement needs of automobile engineering graduates in Nigeria to effectively maintain hybrid vehicles. A survey research design was used, with a sample size of 265, including 243 practicing technicians and 22 lecturers/instructors from five tertiary institutions. A structured questionnaire was used for data collection, validated by three experts. The Cronbach alpha method was used to determine the reliability coefficient, yielding .870. The study found that automobile engineering graduates needed improvement in 27 skills areas for servicing hybrid car engines and support systems, 13 skills areas for diagnosing faults in hybrid car engines and support systems, and 9 skills for repairing faults on hybrid car engines and support systems. The study recommended incorporating 49 skill items needed by automobile maintenance technicians into vocational/technical institutions' training programs, progressive training and retraining of teachers, lecturers, and instructors, organizing seminars and workshops for technicians, and establishing evening programs as vocational improvement centers under entrepreneurial programs in monotechnics, polytechnics, and technical colleges of education.***

Indexed Terms- ***Technological Skills, Automobile industry, Hybrid, TVET Graduates***

I. INTRODUCTION

The automobile industry is experiencing significant growth due to the rise of technology and the economy. As a vast and diverse market, it has become a status symbol for various industries, sectors, societies, and economies worldwide. The industry is becoming more technologically advanced, with computerized systems and sophisticated systems. The International Labour Organization (ILO, 2020) sees the automobile as one of the most successfully manufactured products in recent time. It is perceived as a fast, comfortable, flexible and affordable mode of transport and has become a status symbol or means to reflect identity. Despite its capital-intensive nature, it drives innovation, generates billions of dollars in investment, and creates millions of jobs and livelihoods (United Nations Conference on Trade and Development, UNCTAD, 2018 & 2019). The automobile industry has evolved from horse-driven carts to complex machines like horseless carriages, modern automobiles, and hybrids (Wyman, 2017). These innovations have led to higher efficiency, improved fuel consumption, mileage, alternate energy sources, computer-assisted systems, and more research and development opportunities. Hybrid cars combine at least one electric motor with a gasoline engine, recapturing energy via regenerative braking. The US Environmental Protection Agency (2021) states that hybrid vehicles typically achieve greater fuel economy and lower emissions than conventional ICEVs, reducing air emissions by up to 90% and cutting carbon dioxide emissions in half. Some authors predict that hybrids will dominate new car sales in the US and elsewhere over the next 10 to 20 years (Alliance, 2016). The combined market share of new gasoline hybrid and plug-in hybrid light-duty vehicles is expected to reach 9.9% for the 2021 model year, from 5.4% in the 2020 model year. This influx of hybrid

cars requires technological skills beyond what roadside automobile maintenance mechanics can handle.

Hybrid vehicles are sophisticated machines with numerous efficient and reliable mechanical, electrical, electronic, and computerized components and systems. These innovations have made hybrid cars more comfortable, cleaner, faster, and more economical than their predecessors (Giri, 2010). Users of hybrid cars would expect value services for what they own and pay for at the point of maintenance, with a sense of confidence when there is need to visit the maintenance shop. This has led to the need for competent technicians to meet the challenges in the maintenance sector of the automobile industry. Technological skills for servicing a hybrid vehicle engine and its essential systems include all preventive routine maintenance tasks, such as following service manuals, testing and adjusting components, and performing lubrication services (oil lubrication service). Engine servicing may require the engine to be removed and disassembled to enhance performance (Erjavec, 2014 and Giri, 2010). For an automobile technician to effectively service a hybrid vehicle engine and its essential systems/components, they must have knowledge and understanding of how the engine works, materials, circuit boards, processor chips, and computer application (Fetherston, 2017). They should also be able to read, understand, and interpret charts, service manuals, journals, and the internet for relevant contemporary technological knowledge (Starz, 2011; Erjavec, 2014; Olson, 2018 and Giri, 2010). Technological skills for servicing the automobile engine include inspecting, testing, and identifying wear on engine components, replacing or adjusting drive belts, inspecting cooling system components, draining, flushing, and refilling cooling systems with recommended coolant, performing oil and lubrication services, inspecting and adjusting cylinder valves, identifying and isolating abnormal sounds, removing and reinstalling engine cylinder heads using correct torque specifications, working within stipulated time frames, identifying genuine spare parts, and adhering to safe practices like wearing safety gear and cleanliness. Diagnosing in hybrid car engines and their support systems aim to determine the nature and cause of a fault after careful examination or inspection of the entire system (Fetherston, 2017). According to Abdullahi (2012) diagnosis is a maintenance task that involves competencies, leading to identifying the nature and cause(s) of any error that inhibits the performance of a system, manifesting as faulty components, problems in vehicle performance, unsatisfactory performance, or total failure of the vehicle. Rea (2010) maintained that in diagnostic approach, it is essential, first, for the technician to get the description of the problem from the owner of the vehicle. He then builds on his basic communication skill, ability to analyze issues, make decision, test and examine the systems and components concerned to ensure their functionality. Giri (2010) points out that there are various diagnostic equipment and tools that suit each situation, from basic electrical diagnosis to engine systems analyzers and On-Board Diagnostic (OBD) tools.

Diagnostics of faults in hybrid engines and their supportive sub-systems require a thorough understanding of the system's functioning. Erjavec (2014) outlines seven steps for diagnosing faults: (1) Gather information about the problem, (2) Verify that the problem exists, (3) Thoroughly define the problem and when it occurs, (4) Research all available information and knowledge to determine the possible cause(s), (5) Locate the problem by testing, (6) Continue testing to pinpoint the cause(s), and (7) Locate and repair the problem then verify the repair. Some hybrid vehicles with computerized engine controls have self-diagnostic systems, making diagnosis easier but still requiring a skilled technician. Technological skills for diagnosing faults include clear communication with vehicle owners, reading and understanding journals, reading and understanding blue prints/technical drawings, charts, critical thinking, investigative attitude, initiative, handling modern diagnostic equipment, and critically analyzing and interpreting faults from diagnosis results (Bellis, 2010). According to Thomas, et al. (2022) ability to conduct engine testing, inspection and examination, ability to inspect components and the systems essential to engine performance for wear e.g. lubrication system and components, ignition system and components, fuel system and components, cooling system and components and starter circuit and components. Others are ability to conduct engine performance test using engine analyzer, ability to distinguish abnormal sounds in the engine and localize such sounds to

specific components or systems, ability to determine confidently needed repairs on components and systems being diagnosed. These skills include ability to select the right tools for the expected repairs, and ability to observe safe diagnostic procedures and regulations (Wyman, 2017; Oslon, 2018; Howells, 2018; Bellis, 2010; and Giri 2010). In modern approach to maintenance, repairs follow diagnosis. A repair is a corrective measure that remedies the problem and brings the vehicle back to life and optimal performance (Erjavec, 2014 and Giri, 2010). Technological skills for repairing faults on hybrid cars involve taking decisions on what actions to take to correct the fault or solve the problem correctly after diagnoses. Repairs may involve complete overhauls, where the engine is removed, disassembled, reassembled, and mounted back(Stasz, 2011; Erjavec, 2014; and Wyman, 2017). Automobile technicians should acquire these skills, including determining needed repairs, choosing the right tools, using precision measuring devices, reading, understanding, and following sequential assembly blue prints, repair manuals, and specifications. Mechanical skills for overhauls include removing the engine for overhaul, disassembling and re-assembling the engine in correct sequence, removing and replacing cylinder heads using correct torque, testing assembled engines, verifying and certifying performance, and repairing and replacing damaged components/parts in engine and systems. Technicians should also be knowledgeable and understand the implications of new technological innovations and information to apply to current and future problem-solving, decision-making, and adhering to modern procedures and safe working procedures and regulations (Wyman, 2017). Automobile maintenance technicians must be skillful enough to follow all maintenance provisions enumerated above, as neglecting any aspect of maintenance can lead to major breakdowns that may be detrimental to the user. For optimal performance, safety, and durability, technicians must strictly and skillfully adhere to all routine checks.

The Nigerian automobile industry relies heavily on importation of vehicles from the US and other countries, with few indigenous manufacturing companies. However, the maintenance sector has grown to become a major industry in Nigeria due to the lack of indigenous manufacturing companies. This has led to the need for technological skills improvement to maintain the upsurge in technological innovations in the automobile industry. Skill development is crucial for the employability of workers and the sustainability of enterprises (Faraday et al, 2011). It should ensure that the skills acquired match the skills valued in the workplace and help workers and enterprises adjust to change by constantly improving their skills to meet new conditions. Improvement needs in skills development underlie vocational choice, development, employability, mobility, and sustainability of socio-economic development in every progressive society (Stevenson, 2013). In Nigeria, polytechnics and colleges of education (technical) are responsible for producing skilled technicians and teachers of technology (FGN, 2013). Polytechnics provide training to impact the necessary skills for the production of technicians, technologists, and other skilled personnel who are expected to fit into the economy of the nation. Colleges of education (technical), vocational/technical education departments of universities, and schools of technical education of polytechnics are responsible for producing technical teachers who possess the intellectual and professional background adequate for teaching vocational and technical subjects at Junior secondary schools. Osinem and Nwoji (2010) further emphasized skill as a manifestation of knowledge that is translated into practical activity. It implies that skill is composed of two components i.e. knowledge and activity where the knowledge component has to do with theories and technical information of a system, trade or occupation and, the activity component has to do with motor and perceptual skill. Technological skill development in this contemporary era embraces cognitive, affective, and psychomotor realms of learning (Thomas & Amaechi, 2016). Vocational and technical institutions must ensure the development of these faculties in their curriculum of training to produce skilled automobile technicians with many opportunities to specialize in various fields such as automobile maintenance, merchandising, body work, fuel service stations, and spare parts dealerships. They involve the movement of the parts of the body such as fingers, hands/arms, legs, body, and head with good coordination (Osinem, 2018).

Automotive graduates who wish to work relevantly and successfully on hybrid automobiles must develop

all-round skills. Cognitive skills help acquire technical knowledge required in the trade or occupation, while affective skills reflect an individual's values, emotions, motives, and interests. Psychomotor skills involve expert and effective movement of body parts, such as fingers, hands/arms, legs, body, and head. With the sophistication of hybrid vehicles due to technological innovations, graduates of these institutions will need skills improvement to satisfactorily service, diagnose faults, and carry out repairs on hybrid automobile engines and support systems.

Therefore, an investigation is needed to find out the skill improvement needs of automobile technology graduates for effective maintenance of hybrid vehicles in Nigeria for global competitiveness.

II. PURPOSE OF THE STUDY

The study aimed at investigating the technological skills improvement needs of TVET graduates to effectively maintain hybrid vehicles in the Nigerian automotive industry. Specifically, the study seeks to determine the technological skills improvement needs for:

1. Servicing hybrid car engine and its support systems.
2. Diagnosing faults in hybrid car engine and its support systems.
3. Repairing faults on hybrid car engine and its support systems.

III. METHODOLOGY

The study adopted the descriptive survey design. The study was carried out in Rivers state of Nigeria. The population for the study was 1287, and using purposive sampling techniques a sample size of 265, comprising of 243 practicing automobile technicians from 120 registered automobile maintenance workshops and 22 lecturers/instructors drawn from 5 tertiary institutions in Rivers State. Federal College of Education (T) Omoku, Portharcourt Polytechnic, and kenule Polytechnic, Bori. Ignatius Ajuru University of Education Portharcourt and Rivers State University. A structured questionnaire containing 63 items was used to collect data from the respondents. The instrument was validated by three experts, one from the Innoson Vehicle Manufacturer, Nnewi; one from Leventis Motors, Port Harcourt and one from department of automobile technology, Federal College of Education (T) Omoku. The questionnaire was trial tested on 30 similar respondents different from the study population. Data obtained from the trial test was analyzed using Cronbach Alpha reliability coefficient (α) to establish the internal consistency of the instrument and a reliability coefficient of .87 was obtained.

Data collected from the respondents were analyzed using weighted mean and improvement needed index (INI) for both required and performance categories in order to answer the research questions. The improvement needs was determined by the formula: $PG = \overline{X}r - \overline{X}_p$ where,

PG = performance gap; $\overline{X}_r$ = mean of the required category; $\overline{X}_p$ = mean of the performance category.

Where the value of PG is positive (+), it means that improvement is needed in that particular skill item because the performance of the automobile technicians in that item is lower than what is required. Where the value of PG is negative (-) or zero (0), it means that no skill improvement is needed in that particular skill item because the performance of the automobile technicians in that item is more than or equal to what is required.

IV. RESULTS AND DISCUSSION

- Research question 1

What are the technological skills improvement needs of TVET graduates for servicing the hybrid car engine and its support systems in the Nigerian automotive industry?

Table 1: Performance Gap Analysis of the Servicing Skills Improvement Needs of Respondents

S/N	Skill Items	$\overline{X}_r$	$\overline{X}_p$	PG $\overline{X}_r - \overline{X}_p$	Rmks
1.	Understand how the engine system works	3.41	3.78	-0.37	INN
2.	Understand circuit boards	3.01	3.24	-0.23	INN
3.	Understand processor chips	2.49	2.94	-0.45	INN
4.	Understand computer application	3.20	3.27	-0.07	INN
5.	Identify engineering materials	3.37	3.07	-0.30	INN
6.	Read charts and service manuals	3.40	2.85	0.55	IN
7.	Understand charts and service manuals	3.27	3.26	0.01	IN
8	Drain, flush and refill cooling system with recommended coolant	3.13	2.83	0.30	IN
9	Perform oil and lubrication services on the engine	3.62	3.02	0.60	IN
10	Inspect and adjust cylinder valves	3.35	2.99	0.36	IN
11	Use dial gauges	3.08	3.06	0.02	IN
12	Interpret engine analyser tests	3.17	2.92	0.25	IN
13	Identify and isolate abnormal sounds	2.19	3.37	-1.18	INN
14	Remove and reinstall engine cylinder head using correct torque specification	3.39	2.11	1.28	IN
15	Use modern/digital measuring instrument and tools	3.32	2.07	1.25	IN
16	Work within stipulated time	2.97	2.65	0.32	IN
17	Identify genuine spare parts	3.46	3.02	0.44	IN
18	Read journals of automobile technology and innovations	3.11	3.37	-0.26	INN
19	Surf the internet for relevant contemporary technological knowledge	3.34	2.99	0.35	IN

Key: IN – Improvement Needed: INN- Improvement Not Needed

- Research question 2

What are the technological skills improvement needs of TVET graduates for diagnosing faults in hybrid car engine and its support systems in the Nigerian automotive industry?

Table 2 Performance Gap Analysis of diagnosing faults skill improvement needs of Respondents

S/N	Skill Items	$\overline{X}_r$	$\overline{X}_p$	PG $\overline{X}_r - \overline{X}_p$	Rmks
1.	Understand journals to update knowledge on latest technological development in automobile	2.88	3.43	-0.57	INN
2.	Read and understand blue prints/technical drawings, and charts	3.35	3.11	0.24	IN
3.	Think critically and to possess investigative attitude	3.37	2.93	0.44	IN
4.	Handle well, modern diagnostic equipment (i. e. perform On-Board- Diagnoses (OBD))	3.72	3.27	0.45	IN
5.	Critically analyse and interpret faults from diagnosis results	3.24	3.00	0.24	IN
6	conduct engine performance test using engine analyser	3.41	2.85	0.56	IN
7	distinguish abnormal sounds in the engine	2.43	3.29	-0.86	INN
8	localise such sounds to specific components or systems	3.24	3.01	0.23	IN
9	Confidently determine needed repairs on components and systems being diagnosed	3.43	2.99	0.44	IN

Key: IN – Improvement Needed: INN- Improvement Not Needed

- Research question 3

What are the technological skill improvement needs of TVET graduates for repairing faults on hybrid car engine and its support systems in the Nigerian automotive industry?

Table 3 Performance Gap Analysis of repairing faults skill improvement needs of Respondents

S/N	Skill Items	$\overline{X}_r$	$\overline{X}_p$	PG $\overline{X}_r - \overline{X}_p$	Rmks
1.	Determine the needed repairs	3.73	3.31	0.42	IN
2.	Choose the right tools needed for the expected repairs	3.64	2.76	0.88	IN
3.	Use precision measuring devices for modern automobile repair work	3.54	2.90	0.64	IN
4.	Read, understand and follow sequentially assembly blue prints, repair manuals and specifications	3.46	2.95	0.51	IN
10.	Repair and replace damaged components/parts in engine and systems	3.51	3.04	0.47	IN
11.	Diagnose and carry out needed repairs on the emission system	3.34	2.95	0.70	IN
12.	Carry out modification (technological design to generate or adopt equipment and technology to serve user need)	3.44	2.99	0.44	IN

Key: IN – Improvement Needed: INN- Improvement Not Needed

V. DISCUSSION OF FINDINGS

The study reveals that automobile technicians need improvement in twenty-seven skills for servicing the modern automobile engine and its support systems. These skills include reading charts and service manuals, interpreting charts, performing checklist service, using oscilloscopes to set ignition timing, inspecting electronic ignition system components, performing engine tune-ups, identifying wear on engine components, using pressure gauges to determine cylinder pressure, adjusting drive belts, replacing drive belts, inspecting cooling system components, and inspecting coolant in the cooling system.

The study also reveals that thirteen skills need improvement for diagnosing faults in modern automobile engines and their support systems. These skills include reading and understanding blue prints, technical drawings, charts, critical thinking, handling modern diagnostic equipment, understanding computer controls, conducting engine testing, inspection, and examination of lubrication system and components.

The study also highlights the need for 27 skills for repairing faults on modern automobile engines and their support systems. These skills include determining needed repairs, choosing the right tools, using precision measuring devices, reading and understanding assembly blue prints, repair manuals, and specifications, disassembling and re-assembling the engine in the correct sequence, and verifying and certifying performance.

These findings align with the findings of Giri (2010), which emphasize the importance of determining needed repairs, choosing the right tools, and disassembling and re-assembling the engine in the correct sequence for effective fault repair in modern automobiles.

CONCLUSION

The study reveals that automobile technology graduates in Nigeria are lacking in the necessary skills to service, diagnose, and repair hybrid cars. The majority of technicians lack the necessary skills for effective maintenance, which are crucial for global competitiveness. The study found that practicing technicians are deficient in 49 skill items needed for effective maintenance, including servicing, diagnosing, and repairs. This lack of knowledge can be attributed to a lack of knowledge about

technological innovations in the industry, inability to embrace retraining and research, and professional skill deficiencies among trainers, lecturers, and instructors in technical and vocational institutions.

RECOMMENDATIONS

The recommendations include:

1. Incorporating 49 skill items needed by automobile maintenance technicians into vocational/technical institutions' training programs to meet global standards and technological innovations.
2. Progressive training and retraining of teachers, lecturers, and instructors should be conducted to equip them with professional and technical skills.
2. Government, automobile industries, and professional vocational associations should organize seminars and workshops for technicians to improve their skills in maintaining modern vehicles. 4. Evening programs should be established as vocational improvement centers under entrepreneurial programs in monotechnics, polytechnics, and technical colleges of education.

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