DEVELOPMENT OF GO KART: AN ASSESSMENT TOOL FOR NC II

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ABSTRACT

This study focused on the development of the Go-Kart as an assessment tool for National Certificate II using the Department Of Science and Technology, Technology Assessment Protocol (TAP-TEEPS). This study used developmental research design and descriptive-evaluative research design with a questionnaire to gather data. The statistical tools used were frequency count and weighted mean. After designing, fabricate, and assembling, the kart was evaluated in terms of its level of technical performance, economic/financial feasibility, environmental soundness, political acceptability, and social acceptability, its level of utility as National Certificate II Assessment Tool along core competencies (Service Wiring Lighting System, Service Engine Mechanical System, Service Steering System, and Perform Brake System Preventive Maintenance). The findings were: the Go-Kart was designed and fabricated according to the specifications detailed in the plan; the Go-Kart showed excellent level of technical performance, high economic/financial feasibility, highly acceptable environmental soundness, very high political and social acceptance; the level of utility of the Go-Kart as National Certificate II assessment tool was high; and the prepared Laboratory Manual as a guide in the use of the Go-Kart along the four selected core competencies was very highly valid.

KEYWORDS

Assessment tool, Go-Kart, Laboratory Manual, National Certificate II

1. INTRODUCTION

One of the main objectives of the Bachelor of Science in Industrial Education program (BSIE) at the Don Mariano Marcos Memorial State University is to produce effective and globally competitive teachers as catalyst of change. As [40] said it focused on development of various knowledge, skills, and attitudes among the students. [13]said that teaching is the most important factor in cultivating student performance. However, many academicians see themselves primarily as experts in their discipline and hold content-oriented starts of teaching. It can then be difficult to motivate them to implement forms of teaching combining active students' engagement, even though there is evidence for the effectiveness of such form of learning. Competencies are components acquired through formal and informal training's. The traditional teaching method emphasizes the transmission of knowledge only. [5]Argue that "addressing the opportunity gap that has allowed inequalities in resources to deprive many students of needed opportunities to learn" as key to educational improvement. It is the ethical responsibility of the educational technologist to make every attempt to encourage and coordinate efforts to empower all students with the required digital skills and access to any device (mobile or stationary) with the needed connectivity so that they may cross the digital divide.

Innovative and dedicated automotive technology instructors as cited by [43] are selected to exploit the classroom environment as resource for learning's,a process whereby an individual or a firm "acquires, creates, and disseminates new knowledge" by combining and recombining different pieces of knowledge into something new.

Innovative teaching is a necessity for all teachers in order to meet the educational needs of the new generations. However, teachers' competency for innovative teaching is a key factor influencing innovative teaching performance. [31] made a case study on Innovation of Automotive Sector of the Philippines. He found out that having awareness of the importance of technology and upgrading, some of the automotive firms are not able to translate this awareness into other technology activities. The case study aimed to provide background of the automotive sector of the Philippines and to understand the challenges being faced by automotive firms (assembler and manufacturer) n terms of innovation.

In relation to innovation theory [35] states that patent system is second policy instrument of technological selection. The Patent system defines property right which supports the incentive for technological innovation. Patent system with limited scope promotes technology and knowledge diffusion. Technology-based innovation include forms such as (a) product innovation, (b) industrial research and development, and (c) technology transfer through imitation and improvement.

Innovation drives economic growth. But what fuels innovation? As productivity grows, so does the economy. In the same vein, this study was conceptualized to innovate the Go- Kart machine
The preceding statements encourage this researcher to contribute his share in the drive to economic growth through innovation--- the development of Go-kart with enhanced feature.[14] The use of innovation is useful in teaching learning process. For instance, the impact of computer simulation on the performance of 65 grade 11 learners in electromagnetism in a South African high school in Mpumalaga province revealed that the learners did not use the simulation individually, but the teachers used them as an interactive demonstration tool to effect better learning.

According to [18] shortage of instructional materials device and equipment affects quality of education in technology. [4] cited on the effect of group project method on students' academic achievement in car battery system in basic technology. It revealed in her study that there is significant difference in post- test academic achievement taught with group project method (GPM) and taught with conventional learning method. [31] cited the study of [2] who mentioned that small numbers of assemblers have access to best industry practice and state of the art technology while larger part manufactures are most small, medium enterprise have low technology levels and face problem of limited capital and lack of skilled workers.

In industrial education system, the technological progress will cause the maladjustment of the manpower supply and demand. As a result, the industrial education should head for the directions of high-qualitative life, technology progress, productivity upgrade, manpower requirement, economic development, and modernization to greet the epoch making approach of the high-tech age as cited by [31].

According to [43] modern automotive technology changes rapidly fast and appears as new technology on a car, which instructors must be following as technology changes. The efficiency of learning need to propose in material package and the efficiency tools for self-study is computer. Because the learner can study every time, everywhere, and everyone. It is easy to access through the learner by networking.

A study on the blended learning is also important as it incorporates blended learning models, which link to e- learning methods with practical sessions on hardware equipment.

Go-kart or karting was born from United States in 1950s, where the engine was taken from discarded lawn engine. Go-kart is a driving and racing miniature, skeleton frame, and rear engine automobiles. Go- kart is a non- popular sport previously. Today it has become one of the most popular sports by multiple group of age as mentioned by McAuley (2008).

This study aimed to develop and use go-kart not for sports racing but for instructional purposes. Based on the findings, the researcher prepared and validated a laboratory manual that integrates different topics like steering calculation, wheel alignment, brake adjustment, lighting circuit and engine mechanical system.

[23] in his work a detailed methodology of virtual design and testing has been presented, to evaluate the dynamic performance of Go-kart vehicle particular attention was paid to the understanding of the behavior of the structural frame, That the most important element in the determination of vehicle turning performance. A validated finite element model once validated has shown excellent capability to reproduce the frame structural behavior.

[26] presented a paper which aims to increase the factor of safety of the Go-kart chassis, which is designed keeping in mind the rules imposed by Go-kart Design Challenge 2015. Theoretical calculation are carried out which have been realized through several analysis. During the impact analysis, the chassis meet the required factor of safety. In order to enhance factor of safety a computer aided design model was altered marginally such it meet safety requirements.

In the study 0f [27], mechanical engineering technology students with interest in automotive technology to design and build electrically powered Go-kart to learn product design, prototyping, and manufacturing. The outcome of such learning experience from the project can be expanded to interdisciplinary project oriented course for engineering students to enhance their learning experiences.

[28] worked on a detailed methodology of virtual design and testing has been presented including the reason of using materials for fabrication of the chassis and axle. The materials used in the chassis is chromally quality 4130 with diameter of 30 mm. Steering system used is Ackerman steering system with tie rod.

[29] researched on static analysis of go-kart. [33] fabricated a go-kart that included lathe work, drilling, milling ,grinding. The design is chosen such as the kart is easy to fabricate in possible aspect. Design process of the vehicle is based on varios engineering aspect depending upon safety and ergonomics, market availability, cost of components and safe engineering process.

Today’s go-kart frames are made from lighter iron and others which are more durable and can absorb more vibration even if it has no suspension. The design and fabrication of a go-kart vehicle gives special attention to improvement of suspension system and dynamics over the previous models, noting the nodal analysis of previous models and the points of review and limitations in old models. New designs try to eliminate the defects of old designs and also implementing the positivity of old designs in the new ones.

Go kart is the simplest form of motorsport but for the author is used for instructional purposes. All go karts such as sprint kart, road racing, indoor karting and speed way karting look alike .

Narrow kart are from 24" to 25" and wider Kart are measured from 27" to 28".With my design I will used 24" chassis frame measured 12" at the center and I will use pipe as a frame.

Go-Kart manufacturer started to do more research and development. To improve the Go Kart in terms of chassis design, speed , braking system and transmission system.

[8] model and analysis of a regular kart structure subjected to real efforts using the Finite Element Method. The researcher made use of the model made by Fray and Santos as a guide.

This paper describes the development and result of the design, fabrication, and evaluation of the go-kart and the laboratory manual for assessment tool.

[14] cited the terms "design, engineering, and technology" (DET).My present research is through this idea on design engineering is my pattern. Scientific ideas within the framework of their existing knowledge are the starting point of cognitive constructivism (Wieman, Adams, & Perkins, 2008). To accomplish this process, learners must be motivated to actively engage with the content and must be able to learn from that engagement. Interactive computer simulations can meet both of these needs

Eniekenemi, & Taiwo (2016) said that students taught with experiential learning strategy performed well than those taught with conventional lecture strategy. It was recommended that teachers of automobile technology should exposed and allow students to face more practical work experiences.

[25] on the effect of group project method on students' academic achievement in car battery system in basis technology, Design is concept usually considered in the context of applied arts, engineering, architecture and other creative endeavor. To design refers to the process of originating and developing a plan for a new object such as machine product, structure, system or component. According from Italians.com, normally a designer requires to consider the aesthetic , functional, and many other aspect of an object or process, which usually requires considerable research, thought, modeling, interactive adjustment, with these concept the researcher used this as guide.

Suryawanshi (2014) designed and simulated a producer gas carburetor, due to the increasing energy demand to keep the sustainable development, there is a major need for utilization of alternative energy source in order to meet stringent emission regulation. He use design with CFD in analyzing combustion process.

The foregoing concept inspired and encourage the researcher to pursue this study to teach students along the core competency of automotive technology such as service wiring/lighting system, service engine mechanical system, service steering system and perform brake system servicing.

[22] on Competency based education , a specialists, who are able to adapt to labor market and ready for new changes, for self-learning. The objectives of modern education in the new condition is intended to be focused not just fundamental knowledge but on the labor market and in the formation of practically oriented skills and competencies.

[11] studied the effective practice for developing competency based learning models in higher education. Self -direction and being able to apply experiences in learning is a key tenets- of a competency-based learning. She cited Weise & Christensen (2014), whose works revealed that

competency-based programs do not measure time spent on task; learning is fixed; time is variable and pacing is flexible.

Requirements and Procedures in Applying for Assessment and Certification (National Certificate (NC)/Certificate of Competency (COC)as stated in training regulation set by Technical Skills development Authority or TESDA are the following

1. New Applicant,
2. Renewal, and
3. Lost/Damaged Certificate.

Technology and Livelihood Education (TLE) and Technical-Vocational- Livelihood (TVL) Track Technology and Livelihood Education (TLE) and Technical-Vocational- Livelihood (TVL) Track specializations may be taken between Grades 9 to 12.

Specialization	Number of Hours	Pre-requisite
Automotive Servicing (NC I)	640 hours	
Automotive Servicing (NC II)	640 hours	

Another issue is that there are data that go kart is being researched on the Philippines setting as a tool for educational purpose.

The ideas on sustainability of instructional materials for technical-vocational courses prompted the researcher to conduct this research keeping in mind that the Go-kart would be a tool to enhance the learning potentials and dynamism of technology students.

Further, the concept and principle of STEEP challenge the researcher stands for Social, Technical, Economical, Environmental and Political Analysis. In the conduct of this study, the researcher would consider the social, technical, economic, environmental and political aspect of the innovated Go-Kart.

STEEP is used to identify the external forces such that it spots opportunity, implement appropriate practices, and break free old assumptions.

Social factors includes current trend in society, life time trends, now a days Go Kart are used for social enjoyment or through community building to get out on boredom.

Technological factors such as the manufacturing maturity, information system and consumer access to technology. It means that the go kart uses technology which is the used of a certain application like Internet Protocols.

Environmental factors sustaining the environment by making a certain locality to become attractive in go kart an irregular land can be landscaped so as to attract costumers, this also make students to care for environment.

Economic factors such as market demand and costumer preferences, the go kart will be used as an income- generation project for the College.

Political factors *include laws, property rights and patents. This means that in making the Go-Kart the researcher would consider the intellectual property rights of those who developed similar go kart.*

The TAP (Technology Assessment protocol) *is a policy analysis, usually undertaken by the DOST, to support decision making about technology or technological projects. It is design to anticipate the gaps and risk associated with technology transfer and utilizatio*n.
The TAP involves three steps: (1).Technology pre-screening or identification; (2) Technology scanning and (3) technology validation.

The above viewpoints imparted additional ideas and provided guidance and concept to this research.

The aforementioned studies guided the researcher in designing, fabricating, evaluating then prepared and validated a laboratory manual for use on the four selected core competencies such as Service Wiring/Lighting System, Service Engine Mechanical System, Service Steering System and Service Brake System.

2. STATEMENT OF OBJECTIVES

The main focus of the study was to develop a Go-kart as an assessment tool for National Certificate II using the DOST Technology Assessment Protocol (TAP-TEEPS).

2.1. Specifically, this study aimed to accomplish the following Objectives

1, Design and fabricate the Go Kart;
2. Evaluate the Go-Kart in terms of TEEPS on the Go-Kart's
    a. Level of technical performance,
    b. Economic/financial feasibility,
    c. Environmental soundness,
    d. Political acceptability, and
    e. Social acceptability;
3. Determine the level of utility of the Go-Kart as National Certificate Assessment Tool along the following core competencies:
    a. Service Wiring Lighting System,
    b. Service Engine mechanical System,
    c. Service steering system, and
    d. Perform Brake System preventive maintenance; and

2.1.1. Time and Place

The Go-Kart was conceived during the First Semester, School Year 2017-2018 at the College of Technical Education, Don Mariano Marcos Memorial State University (DMMMSU) Mid La Union Campus. The fabrication and assembly of the Go-Kart were done at Brgy. Bangcusay, City of San Fernando, La Union.

2.1.2. Definition of Terms

Assessment tool refers to the Go-Kart, which was used to assess the Automotive Technology students' performance along the selected core competencies with the laboratory manual as their guide.

Core Competencies refers to a statement which describes the integrated demonstration of cluster of related knowledge, skills and attitude that are observable and measurable, necessary to perform a job independently at a prescribed proficiency level.

Design **r**efers to the process of originating and developing a plan for the structure and components of the Go –Kart in this study.

Developmen*t* refers to the design, fabrication, assembly, and evaluation of the f the Go-kart in this study.
Fabricate refers to building of parts by cutting, welding, and assembling components made from the materials.

Go-Kart is the output of this study. It is a prototype small vehicle with parts and components as of a vehicle.

TAP/TEEPS serves as an early warning function about the possible positive or negative impacts of technologies to intended beneficiaries.

Technical performanc*eIts indicators include th****e*** *measure of the durability of parts, safety in operation, speed and accuracy, simplicity of the mechanism, precision of design, portability and functionality.*

Economic financial /feasibili*ty means the developed go Kart can be used as an Income generating project to the college*

Environmental soundness means the developed Go kart does not affect the environment

Political acceptability *if the government will approved the developed Go-kart.*

Social acceptability refers to the machine's operation that does not promote gender bias but acceptability to both sexes.

Level of utility *refers to the measure of total satisfaction received by the end-users from using the Go-Kart service and in developing knowledge and skills along the four selected core competencies as required for NCII.*

Service Wiring and Lighting System *is the core competency on carrying out test and repairs of electric wiring and lighting. This standard only applies to 12/24 volt system.*

Service Engine Mechanical System *is the core competency that identifies the competence required of the Go–kart in servicing cooling, lubricating, fuel systems*

Service Steering System *is the core competency that includes conduct of wheel alignment and overhauling of the Go-kart's front wheel.*

Service Brake System *is the core competency that pertains to the conduct of brake adjustment either hydraulic brake or drum brake.*

3. RESEARCH DESIGN

This study used developmental research design and descriptive-evaluative research design. Development design was applied in the first phase of this study, that is, the design and fabrication of the Go-Kart. [37] the purpose of developmental research is to design a new product to address specific need. Once the product is created, it is tested, evaluated, and revised until specified criteria of quality and effectiveness are satisfied. The researcher made innovation to the existing design to come up with the new Go-Kart design. The innovative design included additional part.

Likewise, descriptive-evaluative design was used because the study gathered and described the data and characteristics of what was being studied. According [39] descriptive research design is a method which involves observing and describing the behavior of a subject without influencing it in any way. Descriptive research design is appropriate in this study because it involves a collection of quantitative information that were tabulated along a continuum in numerical form.[9} state that descriptive research involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data collection. It often uses visual aids such as graphs and charts to aid the reader in understanding the data distribution The descriptive–evaluative phase in this study involved the gathering of data using an appropriate questionnaire, then analyzing the data to determine the level of technical performance, economic/financial feasibility, environmental, political and social acceptability of the developed project.

3.1. Materials and Procedures

The materials for the fabrication of the Go Kart were purchased from hardware stores and automotive supply stores in the locality.

It can be gleaned from Table 1 that the materials used to fabricate the parts of the Go-Kart were inexpensive and affordable yielding the total cost of Php 8.456.00. Table 1 shows the 22 items, including their corresponding quantity, description, and unit and total cost.

Meanwhile, the machine shop labor cost, which was based on the current labor cost in the locality, was Php 2,000.00.

Figure 1 shows the step-by-step flow in the fabrication and assembly of the Go-Kart. The diagram shows that the work started with the fabrication of the frame. Next was the assembly of the steering system that composed of knuckle, tie rod, ball joint, steering shaft, steering column, and steering wheel. Then, the engine was mounted with fuel tank, carburetor, and oil tank. Then, the axle and wheel chains and gear were mounted; the axle was mounted by two pillow blocks. Then, the brake assembly, which composed of brake pedal, brake cable, brake shoe and brake drum, was mounted. Then, the accelerator assembly composed of accelerator pedal, throttle cable and carburetor was also mounted. Then the wiring harness was mounted on the chassis followed by the lighting assembly like headlight, directional light and tail light. The upholstery of the seat was done in an upholstery shop. Painting of the frame was done. The last in the flow of work was the bench test of the kart. Finally, lighting was installed and the horn was also tested.

Table 1. Materials Used to Fabricate the Go Kart

Item No.	Quantity	Description	Unit Price (Php)	Total Price (Php)
1	1 pc	Steel pipe ½ Galvanize Iron	60.00	560.00
2	1pc	Solid Stainless shaft 5/8” x 36”	300.00	300.00
3	2pc	Pillow Block 5/8”	168.00	336.00
4	4pc	Bolt and nut 3/8” x 1 ½”	35.00	125.00
5	1 kl	Welding rod	90.00	90.00
6	2pc	Bolt 5/8” x 6”	100.00	200.00
7	2pc	14 teeth sprocket	85.00	170.00
8	1pc	Gear chain	230.00	230.00
9	1 set	Brake drum	100.00	100.00

10	1pc	Carburetor Assembly	1,200.00	1,200.00
11	1pc	Combination Switch	400.00	400.00
12	4pc	Ball joint	160.00	640.00
13	4pc	Bolt screw 5/16" X 1 ½	16.00	70.00
14	1pc	Steering Wheel	1,200.00	1,200.00
15	1pc	Starter Relay	280.00	280.00
16	1pc	3L Battery (12 volt)	480.00	480.00
17	1pc	Kill switch	125.00	125.00
18	2pc	Upholstery	800.00	800.00
19	1pc	Primer paint	100.00	100.00
20	3pc	Spray paint	100.00	300.00
21	1pc	Belt tensioner	750.00	750.00
22	1pc	Overhauling kit	1,200.00	1,200.00
		TOTAL COST		8,456.00

The development of the Go-Kart was done in two stages.

3.1.1. Stage 1- Design and Construction Stage

The design and construction stages was conducted from December 2017 to February 2018. Figure 2 shows the design of the frame, which was fabricated with G.I pipe with ½" and 3mm thick. Figure 3 shows the perspective of the Go-Kart, while Figure 4 shows its isometric view.

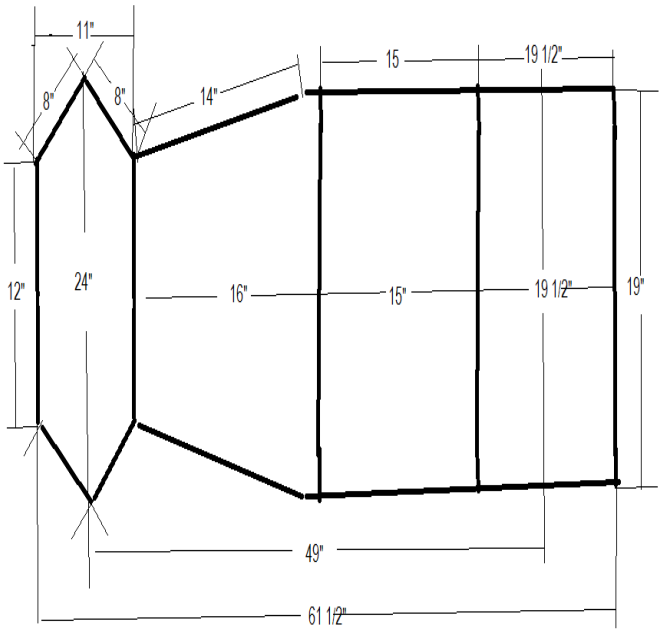

Figure 1. Frame of the Go-Kart

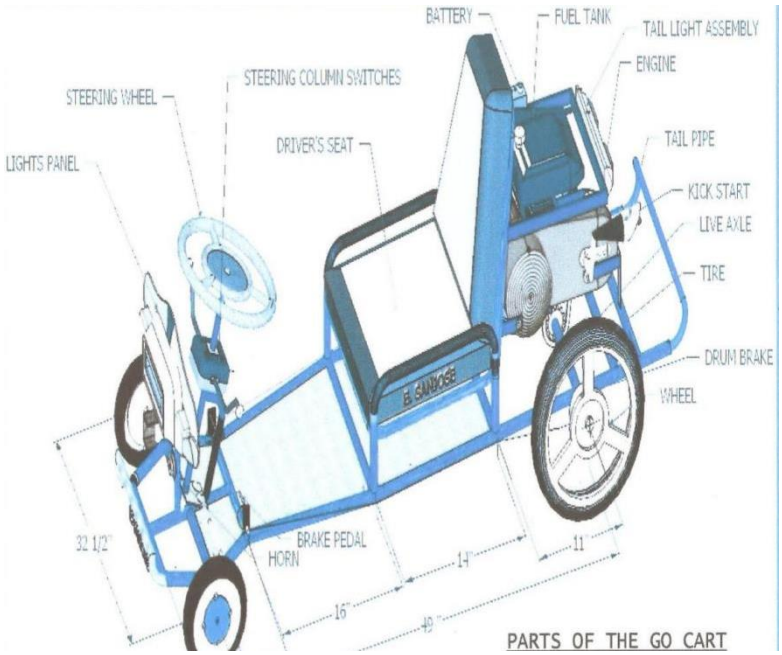

Figure 2. Perspective View of the Go-Kart

3.1.2. Stage II - Validation stage

The validation stage was the second stage in the research protocol for the Go- Kart. The Go Kart was validated by selected mechanical engineers from the College of Engineering, DMMMSU-MLUC; they were experts on machine design. They provided criticisms, comments and recommendation on the design and construction of the machine. Their criticisms and suggestions served as a basis in improving the Go-Kart.

3.2. Instrumentation and Data Collection

The population of the study included 10 selected Automotive Technology students and 10 instructors from the College of Technology and College of Engineering, Don Mariano Marcos Memorial State University (DMMMSU**).**The study used questionnaire as instrument to gather data. Said questionnaire was adapted from [37]. The questionnaire contained three parts. The first part included gathered data to determine the level of technical performance, the level of acceptability on environmental soundness, political and social acceptability. The second part was the level of utility of the Go-Kart in four selected core competencies. The last part determined the level of validity of the Laboratory Manual.

3.3. Analysis of Data

To process its level of technical performance, the Go Kart was subjected to performance test by the identified respondents, who assessed the Kart using specified criteria in the questionnaire. Means were used to quantify the descriptive evaluation.

For economic/viability, a cost and return analysis was conducted using the standard formula: ROI = net income projected based on demand/total cost of investment, multiplied by 100 percent. The assistance of an economics expert was sought to ensure the accuracy and correctness of the analysis.

3.3.1. The categorization of data was a follows

3.3.1.1. Level of Technical Performance

Point ValueRating ScaleDescriptive Rating
5 4.20 – 5.00 Excellent
4 3.40 – 4.19 Very Good
3 2.60 – 3.39 Good
2 1.80 – 2.59 Moderate
1 1.00 – 1.79 Low

3.3.1.2. Level of Economic/Financial Feasibility

Point ValueRating ScaleDescriptive Rating
5 4.20 – 5.00 Very Highly Feasible
4 3.40 – 4.19 Highly Feasible
3 2.60 – 3.39 Moderately Feasible
2 1.80 – 2.59 Slightly Feasible
1 1.00 – 1.79 Not Feasible

3.3.1.3. Level of Environmental Soundness, Political and Social Acceptability

Point Value Rating Scale Descriptive Rating
5 4.20 – 5.00 Very Highly Acceptable
4 3.40 – 4.19 Highly Acceptable
3 2.60 – 3.39 Moderately Acceptable
2 1.80 – 2.59 Slightly Acceptable
1 1.00 – 1.79 Not Acceptable

3.3.1.4. Level of Utility of the Go Kart

Point Value Rating Scale Descriptive Rating
5 4.20 – 5.00 Very Highly Utilized
4 3.40 – 4.19 Highly Utilized
3 2.60 – 3.39 Moderately Utilized
2 1.80 – 2.59 Slightly Utilized
1 1.00 – 1.79 Not Utilized

The assessment of the competencies was done by the Automotive Technology instructor. Below are the Core Competencies of Automotive NC II. Only four (4) competencies were selected as basis for the preparation of the Laboratory Manual. [20] suggested that a laboratory manual should have four competencies and eight learning outcomes. These are highlighted in bold.

3.4. Code No. Core Competencies

ALT723305 Test and Repair Wiring/Lighting System
ALT723309 Service Engine Mechanical System
ALT723312 Service Steering System
ALT723314 Service Brake System

4. RESULT AND DISCUSSION

4.1. Design and Fabrication of the Go-Kart

The development of the Go-Kart was conceptualized to aid instruction in the Automotive Technology courses in the K-12 program and in the tertiary level program. The Go-kart would be a tool to impress upon the learners the importance of learning by using the instructional technology. Tangible instructional materials, like the Go-kart, would concretize and substantiate learning. Such materials are used to improve students' cognitive, psychomotor, and affective skills.

Certain parameters while designing the Go-kart. These were: drivers comfort, ergonomics steering system space and certain mountings.

The assumptions used in the design were the following: (1) Length of the chassis is around 70" to 50"; (2) Weight of vehicle is around 100 kg; (3) Ground clearance is 4"; (4) Gear ratio is 1:1; and (5) To accommodate a driver of height 110 cm.

4.2. Design Elements of the Go-Kart

The Go-Kart has the following design elements:

Chassis. Also known as the frame, the chassis is an extremely important element of the Go-kart. It is the foundation attached to the axles and holds the engine. The developed chassis in this study was 61.5" by 33" (length and width). The body work frame was made of bent GI steel pipes welded together with the engine, four wheels, and tires to it. It has no suspension and differential. Figure on page shows the chassis or frame design.

Engine. It is a two-stroke engine,50-cc Yamaha 1997 model.

Transmission system. It consists of drive train, chain, sprocket and rear axle with pillow blocks-centrifugal clutch to avoid direct acceleration after starting the engine. The Go-kart's transmission system has no differential compared to conventional transmission.

Tires. The Go-Kart's front tire is 5.5" while its rear tire is 10".

Brakes. The brakes are the single drum brakes situated in the rear axle and the steering assembly.

Steering system. The steering system includes the steering wheel, tie rod ends, (ball joint), steering knuckle arm, and steering gear that makes the pitman arm swing from left to right. The *Ackerman* principle is used for steering when the Go-kart enters a curve to guide the wheel to steer in a direction, where it helps the driver to steer with minimal effort and makes both tires parallel to each other to drag. It is used for negative camber, that is, when the wheel top is tilt downward and positive camber is tilt upward.

Stub axles. Is the reverse Elliot type

*Ball Joint***.** This isa socket and a ball stud housing that rotates and tilts to transmit steering action the ball joint was purchased from an auto supply.

*Tie rod***.** This is the rod in the steering system that links the pitman arm, the tie rod has a bolt on both end with diameter of 5 1/6" and 1 ½ " long and is attached to a 5/8" pipe and is welded with E6013 electrode.

Steering Shaft. This is a rod that connects the steering gear box to the steering wheel.

4.3. Assembly of the Go-Kart

Welding the steering shaft to frame. Centralizing the steering was done so that the kart would steer evenly in both direction and tracking well in straight line.

*Installing the pillow block plate***.** The pillow block serves as the bearing for the live axle.

*Installing the engine to the frame***.** A bracket with two holes are used hold the engine to the frame.

Accelerator pedal. Thisis foot-operated and its function is to activate the carburetor pump that pushes the gasoline inside the main jet passing through the carburetor venture and into the engine cylinder. The pedal is link to throttle cable.

*Brake pedal***.** This was installed on the left side of the driver; it is activated by the left foot pedal.

Brake shoe. This resembles a horse shoe with brake pad. It measures from 6 mm thick when it is new and 3 mm when it needs to be replaced (www.49ccscoots.com).

Brake assembly. Go karts use two types of brake assembly: a disk brake and the drum brake. This study made use of the drum brake assembly.

*Installing the seat***.** The seat was made of foam with two-inch thick with upholstery or leather cover.

Installing the steering column switches. The main feature of the Go-Kart is the steering column switch. The last component to be installed is the chain and gear drive, as shown in Plate 33 on page .

*Painting the Go-Kart***.** This was the last phase of the assembly. All surfaces with irregularities were sanded and coated with primer, the first coating that gives adhesion to dent parts and covers unwanted surfaces. Next is the painting of lacquer paint to cover the primer paint. The last coating was the gloss paint that served to cover the lacquer paint and to give shining color to the surfaces.

4.4. Evaluation of the GO-Kart

4.4.1. Level of Technical Performance

To assess the technical performance of the Go-Kart, 10 expert evaluators and 10 end-users were tasked to look into the durability, safety in operation, speed and accuracy, simplicity, precision of design, and functionality of the Go-Kart. The operation of the kart was demonstrated by the researcher. After that, the experts and end users accomplished an evaluation form, which covered seven indicators to assess the level of technical performance of the Go Kart.

Table 2 shows that the level of technical performance of the Go Kart was excellent (4.23). The findings indicates that the Go-Kart had passed the technical performance that according to [19] creates a Go-Kart that possesses good performance and feature. In terms of durability of parts the expert evaluators and end users and end-users perceived that the Go Kart was excellent (4.22), which indicates that they do not break down.

Table 2. Level of Technical Performance (n=10)

Indicators	Experts		End Users		Overall	
	Mean	DR	Mean	DR	Mean	DR
1. Durability	4.20	E	4.23	E	4.22	E
2. Safety in Operation	4.50	E	3.95	VG	4.23	E
3. Speed and Accuracy	4.10	VG	4.20	E	4.15	VG
4. Simplicity of the mechanism	4.30	E	4.38	E	4.33	E
5. Precision of the Design	4.26	E	4.08	E	4.17	E
6. Portability	4.45	E	4.15	E	4. 20	E
7. Functionality	4.10	VG	4.45	VG	4.28	V
Weighted Mean	4.24	E	4.21	E	4.23	E

Legend:DR- Descriptive Rating, E- Excellent , VG- Very Good

It can be inferred from the finding that the Go-Kart is durable as to parts used. The materials used to fabricate Go-kart are of high quality following the prescribed kind of materials to use. The parts were screwed and welded well.

In terms of operation, the level of performance was also excellent (4.23), which indicates that the machine is safe to operate. All procedures of operation were stated or described clearly in the Laboratory Manual, which served as a guide for end-users to ensure that the machine runs smoothly and safely.

The evaluators also observed that the Go-Kart's speed and accuracy were in excellent condition (4.15). This indicates that the movable parts are fitted accurately and that the alignment and assemblies were properly done.

The finding in this study runs parallel to that of [26], whose study aimed to increase the factor of safety of the Go-kart chassis, which was designed keeping in mind the rules imposed by Go-kart Design Challenge 2015. Theoretical calculations were realized through several analysis. During the impact analysis, the chassis met the required factor of safety.

As to simplicity of mechanism, both group of evaluators perceived that the Go Kart possessed simple mechanism. The excellent (4.33) condition indicates that its parts were simple and

aesthetically designed. The finding implies that the machine is simple. However, it also possesses essential mechanisms for the users to explore and to utilize.

The evaluators, likewise, perceived that the design of the Go-Kart was very good (4.17), which indicates that it was precise to suit the specified speed, fuel efficiency, and operation of the machine.

In terms of portability, the Go-Kart was comparatively light and easy to transport from one place to another; it was not bulky. Storage does not require too much space. The rating was excellent (4.20).

Lastly, in terms of functionality, the Go-Kart yielded excellent (4.28) condition. The finding indicates that the machine can perform its functions without causing internal/external strain. The finding implies that functionality is important to be safe as[19] has said. It would be very catastrophic if it does not possess this.

Overall, the finding runs parallel to the findings of[30], who created a Go-Kart that possesses good technical performance.

4.5. Economic/Financial Feasibility

Table3 indicates that the economic /financial feasibility of the Go-Kart was high (4. 30). Although the two groups of evaluators yielded different ratings, where the experts gave very highly economic/financial feasibility rating (4.35) as against that of the end-users who gave a highly feasible rating (4.25), the overall result indicates that the go-Kart was not difficult to develop because the materials needed to fabricate the parts were inexpensive. Moreover, these materials were available in the local market. Even the equipment and tools were available in the machine shops. As [33] has said, a Go–Kart is easy to fabricate if parts are available in the market and the components are cheap. Further, the maintenance was not complicated, that is, the Go-kart is easy to clean because of its simple design and structure.

Table 3. Economic/Financial/ Feasibility of the Go-Kart (n=10)

Indicators	Experts		End-users		Overall	
	Mean	DR	Mean	DR	Mean	DR
Cost in terms of 1. Maintenance. The Go-Kart does not require complex cleaning.	4.50	VHF	4.10	HF	4.30	HF
2. Affordability. The Go-Kart is not expensive; it is affordable to end-users.	4.20	HF	4.40	VHF	4.30	HF
Overall Weighted Mean	4.35	VHF	4.25	HF	4.30	HF

Legend: DR- Descriptive Rating VHV- Very Highly Feasible HV- Highly Feasible

4.6. Environmental Soundness

Table 4 shows that the environmental soundness of the Go Kart was highly acceptable (4.15). This indicates that the Go-Kart does not pose threat to environmental sustainability form hazardous effect to plants, animals, and human welfare nor do raw materials pose danger to biodiversity.

It can be inferred from the findings that the development of the Go-Kart, from beginning to end, is in essentially harmony with the school environment, where it would be used. It does not cause pollution. It means that the environment--with all its complexity, essential cycles, and relationships--remains intact, functioning, and healthy. Further, the finding implies that the go-Kart was developed without generating environmental burdens.It uses resources in a sustainable manner, that is, without destroying the living things around. Rather, it lends support to the rationale for sustainable development and the importance of meeting the needs of the present.The rise of unexpected threats from its development and use is beyond reason.

The finding supports that of [30] who stated that the Go-Kart environmental impact depends on the acceptance of the community.

Table 4. Environmental Soundness of the Go-Kart (n=10)

Indicators	Experts		End-users		Overall	
	Mean	DR	Mean	DR	Mean	DR
1. The making of the Go-Kart does not pose threat to environmental sustainability	4.10	HA	4.0	HA	4.05	HA
2. Does not pose hazard to human welfare	4.00	HA	4.50	VHA	4.25	HA
Overall Weighted Mean	4.05	HA	4.25	VHA	4.15	HA

Legend: DR- Descriptive Rating VHA- Very Highly Acceptable HV- Highly Acceptable

4.7. Political Acceptability

Table 5 shows that the Go-Kart's political acceptability was very high (4.25). Both groups of evaluators yielded very highly acceptable results (4.20 and 4.30, respectively). They affirmed that the technology met regulatory requirement and standard of utilization (4.30), which means that the development of the Go-Kart did not violate any law, policy, regulation, or standards; rather, it conformed to all requirements thereby satisfying the interests and needs of the end-users. It can be inferred from the finding that the Go-Kart does not, in any way, affect the nature of political issues and aspects that concern the end-users and/or the community.

Table 5. Political Acceptability of the Go-Kart (n=10)

Indicators	Experts		End-users		Overall	
	Mean	DR	Mean	DR	Mean	DR
1. The Go Kart matches the objective and interest of end users	4.30	VHA	4.10	HA	4.20	HA
2. The technology meets regulatory requirement and standard of utilization	4.10	HA	4.50	VHA	4.30	VHA
Overall Weighted Mean	4.20	VHA	4.30	VHA	4.25	VHA

Legend: DR- Descriptive Rating VHA- Very Highly Acceptable HV- Highly Acceptable

Its utilizetion, performance, and economic feasibility are not attributed to politicians' attitudes, opinions, decisions and/or actions. Further, the highly acceptable rating implies that the development of the Go-Kart is not a barrier in the implementation of government projects to solve problems related to motor vehicles such as road traffic jam, widening of roads, air pollution, among others.

4.8. Social Acceptability

Table 6 shows that the social acceptability of the Go Kart was very high (4.35), which indicates that the Go Kart serves the needs of the majority of those whom to seek to benefit especially the Automotive Technology instructors and students who shall use it for teaching-learning purposes. Both groups of evaluators affirm that the Go-Kart is friendly; it can be operated safely by either men or women, that is, with ease and precision.

Table 6. Social Acceptability of the Go-Kart (n=10)

Indicators	Experts		End-users		Overall	
	Mean	DR	Mean	DR	Mean	DR
1. The Go Kart Kart serves the needs of the majority of those whom it seek to benefit.	4.40	VHA	4.20	VHA	4.30	VHA
2. The kart can be operated by both sexes with ease and precision.	4.30	VHA	4.50	VHA	4.40	VHA
Overall Weighted Mean	4.35	VHA	4.35	VHA	4.35	VHA

Legend: DR- Descriptive Rating VHA- Very Highly Acceptable

Particularly the Automotive Technology instructors and students who are directly concerned by the development project. They were informed, consulted in a transparent way on the economic/financial benefit of the project. Moreover, this finding implies that the Go-Kart can be adopted and used for the benefit of the end-users, as claimed by [30].

4.9. Overall Assessment of the Go Kart

Table 7shows the overall assessment of the Go Kart. The overall mean rating of 4.25 indicates that the Go-Kart was in very good condition as a tool for Automotive NCII. It can be gleaned from the finding that, among the indicators, "social acceptability" ranked highest (4.35) and "economic/financial feasibility" was second (4.30). Meanwhile, "environmental soundness" ranked last (4.15) but still described as very highly acceptable.

Table 7. Summary Assessment of the Go-Kart (n=10)

Indicators	Experts	End-users	Overall	DR
1. Technical performance	4.25	4.21	4.23	Excellent
2. Economic/financial feasibility	4.35	4.25	4.30	Highly Feasible
3. Environmental soundness	4.05	4.25	4.15	Highly Acceptable
4. Political acceptability	4.20	4.30	4.25	Very Highly Acceptable
5. Social acceptability	4.35	4.35	4.35	Very Highly Acceptable
Overall Weighted Mean	4.35	4.27	4.25	Excellent/Very Highly Feasibible/ Very Highly Acceptable

The overall findings implies that the Go- kart, as according to [30] satisfies the interests and needs of the end-users considering excellent technical performance, high economic/ financial feasibility, environmental and environmental issues.

4.10. Level of Utility of the Go Kart in terms of Four Selected Competencies

Table 8 shows that the level of utility of the Go Kart on the four competencies such as service wring and lighting, service engine mechanical system, service steering system and perform brake system preventive maintenance was high (4.08). The Go Kart's high utilization rating indicates all competencies were satisfied, with service wiring/lighting system and service steering system gaining the highest level (4.44) The finding indicates that the two competencies are very useful in giving knowledge and skills as preparation in taking the NCII.

Table 8. Level of Utility of the Go-Kart along the Four Selected Core Competencies

Indicators	Overall	DR
A. Service Wiring/Lighting System 1. Interpret lighting system circuit diagram	4.40	Very Highly Utilized
2. Install electrical devices such as switches, lights and fuse Boxes	4.40	Very Highly Utilized
3. Install wires leading to different lights and other relevant Devices	4.50	Very Highly Utilized
4. Identifying wire gauges or sizes	4.30	Very Highly Utilized
AVERAGE	4.40	Very Highly Utilized
B. **Service Engine Mechanical System** 1. Service cooling system (water pump overhaul)	1.00	Not Utilized
2. Service lubricating system. Oil level and condition is checked as per manual instructions.	4.40	Very Highly Utilized
3. Service fuel system. Overhaul carburetor in accordance with the required procedures.	4.40	Very Highly Utilized
4. Emission component inspection procedure	4.30	Very Highly Utilized
AVERAGE	3.52	Highly Utilized
C. Service Steering System 1. Pull out steering system component	4.40	sVery Highly Utilized
2. Disassemble steering system components	4.40	Very Highly Utilized
3. Replace damaged parts based on service manual	4.50	Very Highly Utilized
4. Assemble steering system	4.40	Very Highly Utilized
AVERAGE	4.43	Very Highly Utilized
D. **Perform Brake System Preventive Maintenance** 1. Adjust brake clearance to specification (drum)	4.70	Very Highly Utilized
2. Change hydraulic brake fluid without spillage	3.10	Moderately Utilized
3. Fill assembly at specific level	3.20	Moderately Utilized
4. Perform bleeding of hydraulic system according to the required steps and procedure	3.20	Moderately Utilized
5. Conduct brake pedal pre-play and height as per specification.	3.10	Moderately Utilized
6. Adjust emergency brake	3.10	Moderately Utilized
7. Safety procedures in performing brakes system.	3.40	Highly Utilized
AVERAGE	3.94	Highly Utilized
OVERALL AVERAGE	4.08	Highly Utilized

Meanwhile, the lowest was that of the Service Engine Mechanical System (3.52) although still described as highly utilized. This indicates that the Go-kart can supplement knowledge and skills.

The overall findings implies that the Go-kart can be regarded as utility model for experiential learning. Innovative teaching like the development of Go Kart is important for the present and future of education to help students to reach their full possibilities. Higher education serves the long term intellectual needs of students. For example, new materials may be provided by teachers to help the students to gain new insights, or new channels of intellectual stimulation maybe opened up, students' essential and creative thinking power may be enhanced. The Go-kart would be instrumental in sustaining the learning potentials and dynamism of technology students.

5. CONCLUSIONS

Based on the findings, the following conclusions were drawn:

1. The development of the Go-Kart was consistent with the design and plan of activities.
2. The developed Go-Kart satisfied the standards set by DOST Technology Assessment Protocol (TAP-TEEPS) for National Certificate II.
3. The level of utility of the Go-Kart may be improved.
4. The Laboratory Manual met the needs and interests of the end-users.

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