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A Technological Management on Automotive Wheel-Cylinder Leakage System

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Abstract

The research was conducted at Iloilo Science and Technology University in the Philippines to evaluate the acceptability and effectiveness of an innovative wheel-cylinder leakage system model in automotive technology management during the academic year 2021-2022. The study involved students, instructors, and industry experts who evaluated the device's effectiveness, quality, safety awareness, and health. A quasi-experiment method, specifically survey research, was used, with questionnaires given to first and second-year Bachelor of Industrial Technology students, instructors, supervisors, managers, technicians, and operators. The data was analysed using total weighted points, weighted mean, and correlation. The findings indicate that the model meets the Automotive Engineering Association standards for industries and is highly effective in acceptability, effectiveness, safety awareness, and health. The study recommends adopting the model for end users' automotive maintenance and safety.

Keywords: *Innovation, Wheel-Cylinder leakage system model in automotive, Safety awareness and Health, technology management, Effectiveness, Acceptability*

1. Introduction

Automotive brakes are crucial for safety and economic growth, as they provide fast and quality service to vehicles. Failure of brakes can significantly impact lives and businesses (Uti.edu, 2022). Different characteristics of brake systems affect performance during continuous operation and can decrease under extreme heat conditions. Non-conformance and poor maintenance can lead to accidents that can result in death (Montoya-Alcaraz et al., 2020).

A study in Ghana (Oduro, 2012)) found that 40% of vehicle users believe brake failure is caused by low brake fluid, while 33% are due to brake overheating. The Moneymax.ph (2022) espoused that law enforcement agencies should ensure vehicle maintenance and intensify brake servicing campaigns. In the Philippines, losing control of brakes is one of the top four causes of road accidents, causing significant property damage. Late registrations of deaths have increased by 282% and 182% compared to 2019. Elearningindustry.com (2022) recommended improving efficiency. Institutions and industries should innovate gadgets to meet workers' needs, and the current repair process often involves bleeding the brake, leading to a lack of time management and safety.

However, periodic maintenance also corresponds to high expenses if the vehicle is brought into the car shops. On the part of the middle-class family with cars, this will add to their finances due to the rates offered by the car shops because of the equipment invested to provide services. So, a unique tool is developed to minimise this cost and establish affordability.The Wheel Cylinder Leakage Tester (WCLT) aims to address the problem of repairing hydraulic brake systems, focusing on wheel cylinder brake leakage. The innovation aims to minimise

accidents and save time for technicians in performing repairs and replacements without assembling and installing parts on the brake drum. The WCLT also helps determine the standard pressure of hydraulic brakes through pressure readings on gauges. Further research is needed to introduce new procedures for managing brake problem treatment.

2. Literature Review

The early brake system in car history began with wooden block brakes in the 1890s. The modern automobile drum brake was developed in England in the 1890s, with the first caliper-type disc brake patented in 1902. The first sustained mass production of modern automotive disc brakes was in 1955 (Abebrakes.com, 2023). Today, there are two brakes: drum brakes, used in luxury vehicles and SUVs, and disc brakes, used in Asian utility vehicles. Commercial light vehicles and heavy trucks primarily use drum brakes. Most modern passenger vehicles and light vans use a vacuum-assisted brake system (Sun, (2022).

Base brake components are essential parts of a vehicle's brake system, including the brake pedal, power assist system, master cylinder, hoses, pads, drums, balance controls, brake pressure warning systems, and parking brake pedal. According to the PNP-Highway Patrol Group, Metropolitan Manila Development Authority, and Philippine Statistics Authority, the top causes of road accidents in the Philippines are losing control of the wheel, driving under the influence of alcohol, engine mechanical failure, losing brakes, overspeeding, using a phone while driving, turning without signalling, bad overtaking, and jaywalking pedestrian lane (Tupas in Philippines Star, 2023).

The study explores using grey system theory as an alternative control method for sliding-mode control in antilock braking systems. Grey system theory has specific prediction capabilities, making it a viable alternative when conventional methods cannot meet desired performance specifications. The proposed controller achieves faster convergence and better noise response than conventional approaches. Yap & Sweeney (2007) extended the study to incorporate service quality literature from Zeithaml and Bitner, Teas et al., Parasuraman, Zeithaml and Berry, and others. The 'zone of tolerance' (ZOT) refers to the extent to which customers recognise and are willing to accept variation in service levels. Accurate and timely road identification is essential for ABS, and various methods have been proposed. This paper proposes a method using the first pressurisation time, dropped wheel speed, and slope of the dropped speed at the end of decompression. In conclusion, grey system theory can be a viable alternative control method for sliding-mode control in antilock braking systems, offering faster convergence and better noise response.

Gerlough &Huber (1975) developed the Vehicle Modeling Traffic flow theory, which focused on ergonomic brake pedals for effective control, while the Technology Acceptance Model (TAM) models user acceptance and use of technology. It suggests that perceived usefulness and ease of use influence decisions, with social influence, age, and gender also playing a role. TAM has been continuously studied and expanded, with significant upgrades, including TAM 2 and UTAUT. A TAM 3 has been proposed for e-commerce, considering trust and perceived risk. Service Quality Measurement has two perspectives: internal (zero defect) and external (customer perception, expectation, satisfaction, attitude, and delight). The external perspective is increasingly important due to increasing consumer awareness, changing tastes, and growing expectations. Alexandris, Dimitriadis, and Markata (2002) also amplified the works of Parasuraman, Zeithaml, and Berry's Service Quality definition, which measures the degree and direction of discrepancy between consumers' perceptions and expectations, which can affect their future behaviour.

The Vehicle Modeling Traffic flow theory focuses on ergonomic brake pedals for effective control, while the Technology Acceptance Model (TAM) models user acceptance and use of technology. It suggests that perceived usefulness and ease of use influence decisions, with social influence, age, and gender also playing a role. TAM has been continuously studied and expanded, with significant upgrades, including TAM 2 and UTAUT. A TAM 3 has been proposed for e-commerce, considering trust and perceived risk. Service Quality Measurement has two perspectives: internal (zero defect) and external (customer perception, expectation, satisfaction, attitude, and delight). The external perspective is increasingly important due to increasing consumer awareness, changing tastes, and growing expectations. Parasuraman, Zeithaml, and Berry's Service Quality definition measure the

degree and direction of the discrepancy between consumers' perceptions and expectations, which can affect their future behaviour.

3. Prior Art

The study by Connell and Wright (2016) and Beck (2006) discusses various aspects of brake system diagnostics and reporting systems. Wright's study focuses on a brake cylinder limiting valve, which combines actual and intended brake cylinder pressure to prevent venting if the actual pressure exceeds the intended pressure by a predetermined threshold amount. Beck's study includes an on-board brake system diagnostic and reporting system for a pneumatic brake valve on a rail car, which includes a brake pipe transducer and a brake cylinder transducer. A processor receives measurements from the transducers, compares them against stored performance profiles, determines brake status, and prepares an event report for preselected brake statuses. Tideberg's (1987) study discusses a hydraulic fluid bleeding apparatus for removing air from a closed hydraulic brake system. The apparatus includes a container, a sealable lid, and two air conduits tightly mounted through the lid. The first conduit has a liquid-level check valve at the inner distal end, while the second conduit is connected to the brake system's bleed valve or petcock. The fluid flow character is visible through a transparent hose. Vaughn's (2015) study discusses a single-car test interface device, which includes a housing, source port, brake pipe port, and valves selectively interconnecting the ports to perform tests. A brake cylinder sensor is connected to a brake cylinder tap, and a sensor module is mounted on the interface device for determining pressure at the test ports. A controller is connected to the valves, sensor module, and brake cylinder sensor, including a program performing multiple component tests that form a single car test. The interface device also includes reservoir charging valves controlled by the controller.

4. The Technology

A wheel cylinder leakage tester is a device that can hold and test a wheel cylinder without removing it from the brake drum, accurately measuring fluid leaks and determining if it needs replacement or repair. It includes a pressure gauge, holder adjuster, and return spring to adjust the cylinder's length. The device is essential for identifying fluid leaks and ensuring the proper functioning of the brake system. It uses a C-type holder, piston adaptor, pressure gauge, piston holder adjuster, and return spring to ensure the piston's original position. The device is made of iron metal and uses a hydraulic pressure gauge. A new bleeding procedure has been developed to perform bleeding and leakage testing of the wheel cylinder, ensuring the wheel cylinder is free from leakage before installing a brake. This innovative process ensures the wheel cylinder is free from leakage before installin

5. Study's Framework

Kirkpatrick's hydraulic mechanism in Ahmad et al. (2006) is crucial in various tools and equipment, including automobile hydraulic brakes. Different brakes, such as disc, drum, and combination, are available, and pedal ratio and master cylinder sizing are essential. The hydraulic system consists of a wheel cylinder housing a piston, which generates hydraulic pressure to push two shoes against the drum's inner surface. Automotive braking systems must be thoroughly tested before use, and the driver's brake pedal force must be sufficient for smooth and controlled vehicle stops. Hillson's (2015) risk theory focuses on identifying and assessing safety and security problems through risk analysis and management methods. Hale's Safety Management Theory emphasises the need for safety protocols and procedures in every activity to minimise operational uncertainty in the brake system. Parasuraman et al.'s Theory of Service Quality emphasises customer satisfaction with services, emphasising the importance of best practices and servicing guidelines in meeting service expectations. These hydraulic mechanisms are relevant to rapidly improved technology and are essential for smooth vehicle operation.

6. Objectives Of The Study

This research aimed to fabricate and determine the acceptability and effectiveness of an innovative wheel Cylinder Leakage Tester at Iloilo State University during the Academic Year 2021-2022 based on the Technology Model.

Specifically, it sought answers to the following questions:

1. What is the related information of the identified respondent groups regarding age and gender;educational attainment in automotive, related training and seminars attended in automotive; andnumber of years' experience?
2. What are the technical requirements in fabricating wheel cylinder leakage tester concerning design, detailing, quality, effectiveness, andperformance?
3. What is the performance of the innovative wheel cylinder leakage tester based on the quality dimensions of durability, reliability, conformity, aesthetics, andsafety?
4. As perceived by the respondent groups, what is the level of acceptability of an Innovated Wheel Cylinder Leakage Tester based on the quality dimensions?
5. As rated by the respondent groups, is there a relationship between the quality dimensions and the acceptability?
6. Based on the findings, what Technology Model can be crafted?

7. Methodology

7.1. Design and Evaluation

The study follows a system approach of input-process-output flow. The researcher prepares a letter of request, collects questionnaires, and uses numerical rating scales. The process involves assessing inputs through questionnaires, interviews, observations, and statistical computations. The output is the fabrication and evaluation of an innovative wheel cylinder leakage tester. After collecting data, the researcher collects comments and suggestions on the findings and recommends an instructional model.

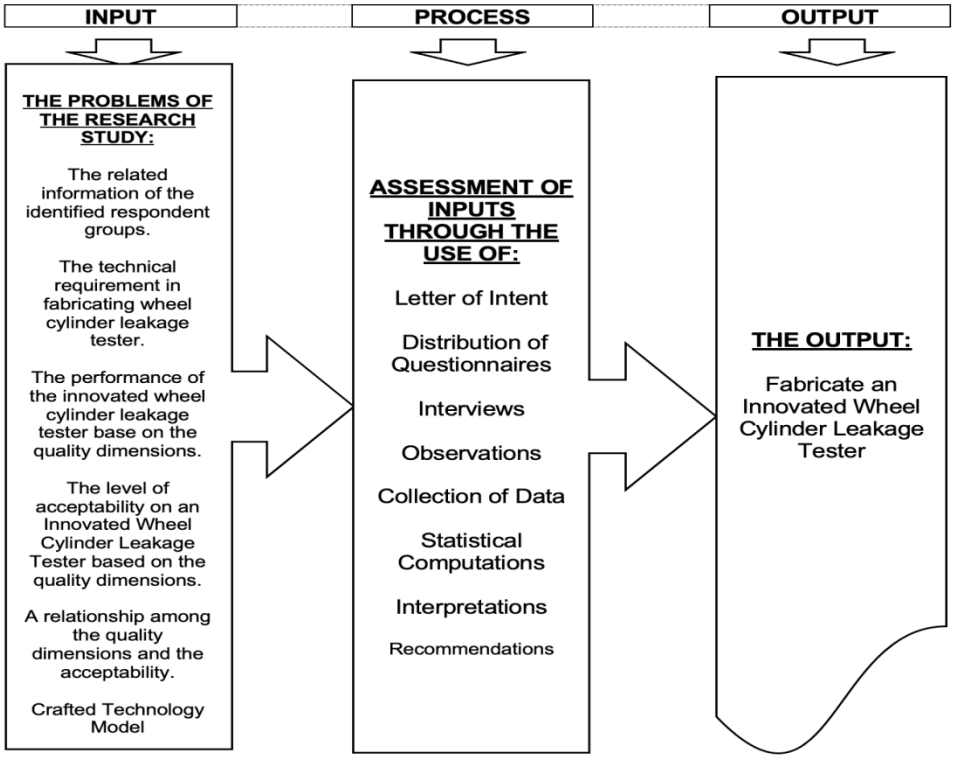

Figure 1. Design and Evaluation Processes.

The wheel cylinder leakage tester is a technology designed, fabricated, and tested to evaluate its performance in the brake system. It is accepted through an instrument and actual testing, with experts from various car industries such as Toyota, Nissan, Isuzu, Mitsubishi Motors, and Mitsubishi Motors' company as technology acceptance or evaluators. The device was measured in design, detailing, quality, effectiveness, durability, reliability, conformity, and aesthetics. The process of bleeding procedures was also evaluated using the

developed technology. The researchers introduced a new bleeding procedure method to the respondents, ensuring it was acceptable to the evaluator. The innovation theory of Rogers identified five attributes that impact the adoption rate: relative advantage, compatibility, complexity, trialability, and observability. This work seeks to improve existing theories on innovation processes, supporting automobile companies and their managers to innovate gadgets that improve performance and quality of service. Planning involves producing a wheel cylinder leakage tester using scrap materials from the surrounding iron metal, which can hold brake system pressure. Fabrication is conducted at the ISAT-U main campus's mechanical shop, using scrap materials to create a quality gadget. The final output of the gadget is subject to innovation in terms of the final output that fits the actual performance of the gadget. Performance is based on actual testing of the device on brake bleeding repair, with respondents observing the accuracy and safety of the device.

7.2. Respondents of the Study

The study used questionnaires from various respondent groups, including first-year and second-year Bachelor of Industrial Technology students, instructors, supervisors, managers, technicians, and operators. The results were precise and accurate, and the device's acceptability was validated by industry experts, considered skilled in their respective fields. The Technology Model of an Innovated Wheel Cylinder Leakage Tester survey was also discussed.

7.2. Instrumentation

The researcher utilised a questionnaire to evaluate the device's design, performance, detailing, features, safety, durability, reliability, conformity, quality, and features. If the device passes the evaluation, it is considered acceptable and usable by any company, industry, and technician in the Philippines. It is highly recommended that shops and industries use the wheel cylinder leakage tester to safely and accurately handle brake systems, adopting the new method of bleeding procedures using the gadget.

8. Results And Discussion

8.1. Respondent's Profile

8.1.1. Age and Gender

Table 1. Age and Gender

Age Bracket	Gender		x	%
	Male	Female		
41 years Old & Above	13	1	14	10.07
31 to 40 Years Old	12	0	12	8.63
21 to 30 Years Old	65	1	66	47.48
20 years Old & below	45	2	47	5.03
Total	135	4	139	99.99

Table 1 demonstrates the chosen age groups: 20 and younger, 21 to 30 years old, 31 to 40 years old, and 41 years old and older. Only 135 men and four women out of the 139 designated respondents answered, according to the data gathered from the respondents. This result indicates that 10.07% of respondents were in the age range of 41 years and older, 8.63% were in the 31 to 40 age range, 47.48% were in the 21 to 30 age range, and 5.03% were in the 20 years and under age range. The consequences were that just 5.03% of the study's 139 respondents—or 45 men and two women—replied, yielding a response rate of 47.48% or 64 males and one female responded.

8.1.2. Educational attainment in Automotive

Table 4. Educational Attainment in Automotive

Educational Attainment	Identified Respondent Groups									
	Selected Automotive Students (30)		Automotive Instructors (13)		Automotive Supervisors/ Managers (6)		Automotive /Technician Experts (30)		Automotive Operators (60)	
	x	VD	x	VD	x	VD	x	VD	x	VD
Doctoral Degree	-	-		-	-	-	-	-	4.6	VHE
Master's Degree	-	-	4.6	VHE	-	-	-	-	-	-
College Degree	4.4	VHE			4.8	VHE	4.8	VHE	-	-
Vocational Course	-	-	-	-	-	-	-	-	-	-
High School	-	-	-	-	-	-	-	-	-	-
Elementary	-	-	-	-	-	-	-	-	-	-
Total:	4.40		4.60		4.80		4.80		4.60	
Interpretation:	V.H.E.-VERY HIGHLY EFFECTIVE									

The respondents' educational attainment in the automotive industry is shown in Table 2. It demonstrates six levels of education, including doctoral, master's, college, high school, and elementary. According to the data, only automotive operators received doctorates, with a weighted average of 4.6; automotive instructors had a weighted average of 4.6; selected automotive students had a weighted average of 4.4; automotive supervisors and managers had a weighted average of 4.8; and automotive technicians and experts had a weighted average of 4.8. There were 4.40 for Selected Automotive Students, 4.60 for Automotive Instructors, 4.80 for Automotive Supervisors/Managers, 4.80 for Automotive/Technician Experts, and 4.60 for Automotive Operators. With a total score of 4.64, the table's connotation was "highly effective."

8.1.3. Related Training and Seminars Attended in Automotive

Table 3. Related Training and Seminars Attended in Automotive

Age and Gender	***Age and Gender***									
	Age and Gender		***Age and Gender***		***Age and Gender***		***Age and Gender***		***Age and Gender***	
	x	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**
Basic training in Automotive Systems.	4.6	VHE	4.8	VHE	4.4	VHE	4.6	VHE	4.8	VHE
Automotive Engine System.	4.6	VHE	4.8	VHE	4.4	VHE	4.6	VHE	4.8	VHE
Hydraulic System.	4.6	VHE	4.8	VHE	4.4	VHE	4.6	VHE	4.8	VHE
Automotive Cooling System.	4.6	VHE	4.8	VHE	4.4	VHE	4.6	VHE	4.8	VHE

Automotive Brake System.	4.2	VHE	4.1	HE	4.1	HE	4.2	VHE	4.4	VHE
Automotive Ignition System.	4.6	VHE	4.8	VHE	4.4	VHE	4.6	VHE	4.8	VHE
Total	4.53		4.68		4.35		4.53		4.73	
Interpretation	VHE- VERY HIGHLY EFFECTIVE									

From the identified respondent groups, Table 3 on the related training and seminars attended in the automotive industry reveals that there were only six different types of pieces of training and seminars attended, including basic training in automotive systems, automotive engines, hydraulic systems, automotive cooling systems, automotive brake systems, and automotive ignition systems. According to the data gathered, 4.53 weighted mean responses came from "Selected Automotive Students(30)", 4.68 weighted mean from "Automotive Instructors(13), 4.35 weighted mean from "Automotive Supervisors/Managers(6)," 4.53 weighted mean from "Automotive /Technician Experts(30), and 4.73 weighted mean from "Automotive Operators(60)". With a rating of 4.57, the implications were "very highly effective."

8.1.4. number of years of experience

Table 4. Number of Years of Experience

Number of years of experience	**Identified Respondent Groups**									
	Selected Automotive Students (30)		**Automotive Instructors (13)**		**Automotive Supervisors/ Managers (6)**		**Automotive /Technician Experts (30)**		**Automotive Operators (60)**	
	x	%	x	%	x	%	x	%	x	%
21 years &above	-	-	2	15.38	1	16.66	2	6.66	4	6.66
16 to 20 years	-	-	2	15.38	-	-	15	50	30	50
11 to 15 years	-	-	1	7.69	1	16.66	5	16.66	10	16.66
6 to 10 years	-	-	1	7.69	-	-	4	13.33	8	13.33
2 to 5 years	1	25	3	23.07	4	66.66	3	10.00	6	10.00
One year and below	3	75	4	30.77	-	-	1	3.33	2	3.33
Total:	4		13		6		30		60	

Table 4 lists the respondents' years of experience in the automobile industry, including one year and under, 2 to 5 years, 6 to 10 years, 11 to 15 years, 16 to 20 years, and 21 years and above. Selected Automotive Students(30), Automotive Instructors(13), Automotive Supervisors/Managers(6), Automotive/Technician Experts(30), and Automotive Operators(60) are only a few of the five identified responder categories. Based on the data, only identified respondents (30 Selected Automotive Students) responded. Their ratings were as follows: 4 for the Automotive Instructors, 13 for the Automotive Instructors, 6 for the Automotive Supervisors/Managers, 30 for the Automotive/Technician Experts, and 60 for the Automotive Operators experience in the industry. The implication was that only 15 automotive/technician experts and 30 automotive experts were out of 139 respondents.

8.1.5. Quality

Table 5. Quality

Attributes of Quality	Selected Automotive Students (30)		Automotive Instructors (13)		Automotive Supervisors/ Managers (6)		Automotive /Technician Experts (30)		Automotive Operators (60)	
	x	VD	x	VD	x	VD	x	VD	x	VD
Performance	4.2	HE	4.4	VHE	4.9	VHE	4.4	VHE	4.9	VHE
Functionality	4.2	HE	4.5	VHE	4.8	VHE	4.5	VHE	4.8	VHE
Suitability	4.2	HE	4.4	VHE	4.9	VHE	4.4	VHE	4.9	VHE
Reliability	4.3	HE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
Consistency	4.2	HE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total:	4.22		4.46		4.84		4.46		4.84	
Interpretation:	VHE – VERY HIGHLY EFFECTIVE									

Table 5 shows an Innovated Wheel Cylinder Leakage Tester's Qualities. It demonstrates that the device's quality has five aspects: performance, functionality, suitability, reliability, and consistency. The implications were "VERY HIGHLY EFFECTIVE", with a rated score of 4.56. Based on the data, only identified respondents responded Selected Automotive Students (30) with a result of 4.22 weighted mean: 4.46 weighted mean for Automotive Instructors(13), 4.84 weighted mean for Automotive Supervisors/Managers(6), 4.46 weighted mean for Automotive/Technician Experts(30); and 4.84 weighted mean for Automotive Operators(60).

8.1.6. Effectiveness

Table 6. Effectiveness

Attributes of Effectiveness	**Selected Automotive Students (30)**		**Automotive Instructors (13)**		**Automotive Supervisors/ Managers (6)**		**Automotive /Technician Experts (30)**		**Automotive Operators (60)**	
	x	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**
The equal distribution of brake system.	4.2	VHE	4.4	VHE	4.9	VHE	4.4	VHE	4.9	VHE
The hydraulic system gives the appropriate pressure.	4.3	VHE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
The prevention of safety to the auto vehicle and the mechanics.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total	4.23		4.46		4.83		4.46		4.83	
Interpretation	VHE – VERY HIGHLY EFFECTIVE									

The efficiency of the gadget is seen in Table 6. It demonstrates that the device's performance was limited to three factors: equal distribution of the braking system pressure, adequate hydraulic system pressure, and prevention of safety hazards for mechanics and auto vehicles. Based on the data, there were only identified

respondents from Selected Automotive Students (30), who responded with a weighted mean of 4.23; Automotive Instructors (13) with a weighted mean of 4.46; Automotive Supervisors/Managers (6) with a weighted mean of 4.83; Automotive/Technician Experts (30) with a weighted mean of 4.46; and Automotive Operators (60) with a weighted mean of 4.83. With a rating of 4.57, the implications were "very highly effective."

8.2. The Performance Of The Innovated Wheel Cylinder Leakage Tester Based On The Quality Dimensions

8.2.1.Durability

The device's durability was checked during the commissioning, illustrated by the researcher and the respondents

Table 7. Durability

Attributes of Durability	Selected Automotive Students (30)		Automotive Instructors (13)		Automotive Supervisors/ Managers (6)		Automotive /Technician Experts (30)		Automotive Operators (60)	
	x	VD	x	VD	x	VD	x	VD	x	VD
The device had a clear and distinct piece of work	4.2	VHE	4.4	VHE	4.9	VHE	4.4	VHE	4.9	VHE
The device is slightly different and unique.	4.3	VHE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
The device was for temporary activities	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
The device had a final delivery at the end	4.3	VHE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
The device had a clear objective	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total	4.24		4.48		4.82		4.48		4.82	
Interpretation	VHE – VERY HIGHLY EFFECTIVE									

The device's durability is shown in Table 9. It demonstrates that there were just five factors that contributed to the device's endurance, including the device had a clear and distinct piece of work; it is slightly distinctive; it was used for temporary activities; it had a final delivery at the end; and it had a clear aim. Based on the data, there were only identified respondents from Selected Automotive Students (30), who responded with a weighted mean of 4.24; Automotive Instructors (13) with a weighted mean of 4.48; Automotive Supervisors/Managers (6) with a weighted mean of 4.82; Automotive /Technician Experts (30) with a weighted mean of 4.48; and Automotive Operators (60) with a weighted mean of 4.82. With a rating of 4.56, the implications were "very highly effective."

8..2.2. Reliability

Reliability is usually characterised by the probability of failure or by the time of failure. If failure is considered a single event, regardless of the time, only its probability is of interest. Here, one must distinguish between unrepaired and repaired objects depending on whether the failed object is discarded or repaired and again put into service.

Table 8. Reliability

Attributes of Reliability	Selected Automotive Students (30)		Automotive Instructors (13)		Automotive Supervisors/ Managers (6)		Automotive /Technician Experts (30)		Automotive Operators (60)	
	x	VD	x	VD	x	VD	x	VD	x	VD
Device Lubrication is the lifeblood of any plant that operates rotating equipment.	4.3	VHE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
Device reliability activity is root-cause failure analysis (RCFA).	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Preventive maintenance (PM) hours often consume a large portion of maintenance time, which may result in overtime or the need for contract labour to perform corrective and emergency work.	4.3	VHE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
Improving the performance of shutdowns can have a significant impact on any brake system.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total:	4.25		4.50		4.8		4.5		4.80	
Interpretation:	V.H.E.-VERY HIGHLY EFFECTIVE									

Device reliability activity is root-cause failure analysis (RCFA), preventive maintenance (PM) hours frequently consume a large portion of maintenance time, which may result in overtime or the need for contract labour to perform corrective and emergency work, and Improving the performance of shutdowns, and can have a significant impact on device reliability (Table 8). Lubrication is the lifeblood of any plant that operates rotating equipment. Based on the data, only identified respondents—selected automotive students (30), automotive instructors (13), automotive supervisors/managers (6), automotive /technician experts (30), and automotive operators (60)—responded, with weighted means of 4.25, 4.50, 4.8, and 4.50, respectively. The implications were "very highly effective", with a rated score of 4.57.

8.2.3.Conformity

The device complied with safety standards in performing the device. The materials and accessories used.

Table 9. Conformity

Attributes of Conformity	Selected Automotive Students (30)	Automotive Instructors (13)	Automotive Supervisors/ Managers (6)	Automotive /Technician Experts (30)	Automotive Operators (60)

	x	VD	x	VD	x	VD	x	VD	x	VD
The device has followed the standards.	4.3	VHE	4.6	VHE	4.8	VHE	4.6	VHE	4.8	VHE
The device has complied with safety procedures.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
The device has the following materials and accessories used.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total	4.23		4.46		4.80		4.46		4.80	
Interpretation	V.H.E.-VERY HIGHLY EFFECTIVE									

The device's compliance is shown in Table 9. It demonstrates that there were just four aspects of the device's conformance, including its adherence to safety protocols, compliance with standards, and usage of appropriate materials and accessories. Based on the data, there were only identified respondents from Selected Automotive Students (30), who responded with a weighted mean of 4.23; Automotive Instructors (13) with a weighted mean of 4.46; Automotive Supervisors/Managers (6) with a weighted mean of 4.80; Automotive/Technician Experts (30) with a weighted mean of 4.46; and Automotive Operators (60) with a weighted mean of 4.80. With a rating of 4.55, the implications were "very highly effective".

8.2.4. Aesthetics

Aesthetics is a core design principle that defines a design's pleasing qualities. In visual terms, aesthetics includes balance, colour, movement, pattern, scale, shape and visual weight.

Table 10. Aesthetics

Attributes of Aesthetics	**Selected Automotive Students (30)**		**Automotive Instructors (13)**		**Automotive Supervisors/ Managers (6)**		**Automotive /Technician Experts (30)**		**Automotive Operators (60)**	
	x	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**
Device Structural Balance.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Device color.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Device Extend and Extract Movement.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Device Pattern, shape and Weight.	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total	4.20		4.40		4.80		4.40		4.80	
Interpretation	VHE – VERY HIGHLY EFFECTIVE									

The device's aesthetics, as seen in Table 12. It demonstrates that there were just four aesthetic characteristics of the device, including its structural balance, colour, extend and extract motion, pattern, shape, and weight. Based on the data, there were only identified respondents who responded Selected Automotive Students (30), with a weighted mean of 4.20; Automotive Instructors (13); Automotive Supervisors/Managers (6);

Automotive/Technician Experts (30); and Automotive Operators (60). The implications received a rating of "very highly effective" with a score of 4.52.

8.2.5. Safety

The condition of being protected from or unlikely to cause danger, risk, or injury.

Table 11. Safety

Attributes of safety	**Selected Automotive Students (30)**		**Automotive Instructors (13)**		**Automotive Supervisors/ Managers (6)**		**Automotive /Technician Experts (30)**		**Automotive Operators (60)**	
	x	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**	**x**	**VD**
Read the operating manual of the device carefully, even if you are already familiar with the basics	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Always wear appropriate personal protection equipment (PPE)	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Only operate the device for which you have received full training	4.2	VHE	4.4	VHE	4.8	VHE	4.4	VHE	4.8	VHE
Total	4.20		4.40		4.80		4.40		4.80	
Interpretation	VHE – VERY HIGHLY EFFECTIVE									

Table 11 demonstrates that there are only four factors that contribute to a device's safety: reading the manual carefully, even if you are already familiar with the basics, wearing the proper personal protective equipment (PPE), and only using a device for which you have received thorough training. Based on the data, only identified respondents—selected automotive students (30), automotive instructors (13), automotive supervisors/managers (6), automotive technician experts (30), and automotive operators (60)—responded with weighted means of 4.20, 4.40, 4.80, and 4.40, respectively. With a rating of 4.52, the implications were "very highly effective."

8.3. The Level of Acceptability on an Innovated Wheel Cylinder Leakage Tester Based on The Quality Dimensions

The level of acceptability of an Innovated Wheel Cylinder Leakage Tester Based on the Quality Dimensions was rated by the respondents using Perceived Usefulness, Ease of Use and Users Satisfaction.

Table 12. Level of Acceptability on an Innovated Wheel Cylinder Leakage Tester

Characteristics of Quality Dimensions	**Perceived Usefulness**		**Perceived Ease of Use**		**User's Satisfaction**	
	x	**VD**	**x**	**VD**	**x**	**VD**
The Device was Durable.	4.6	VHA	4.6	VHA	4.6	VHA
The Device was Reliable.	4.4	VHA	4.4	VHA	4.2	VHA

The Device was Conformity.	4.4	VHA	4.6	VHA	4.4	VHA
The Device was Aesthetics.	4.6	VHA	4.6	VHA	4.6	VHA
The device was applying safety.	4.6	VHA	4.4	VHA	4.8	VHA
The Device was Effective.	4.2	VHA	4.2	VHA	4.2	VHA
The Device was Quality.	4.6	VHA	4.4	VHA	4.6	VHA
Total:	4.48		4.45		4.48	
Interpretation:	VHA- VERY HIGHLY ACCEPTABLE					

Table 12 demonstrates that the Innovated Wheel Cylinder Leakage Tester only had 7 Characteristics of Quality Dimensions of Acceptability: The Device Was Durable, The Device Was Reliable, The Device Was Conformity, The Device Was Aesthetics, The Device Was Applying Safety, The Device Was Effective, and The Device Was Quality. According to the data, only identified respondents gave their opinions on perceived usefulness, with a weighted mean of 4.48; perceived ease of use, with a weighted mean of 4.45; and user satisfaction, with a weighted mean of 4.48. With a rating of 4.47, the implications were "very highly acceptable."

8.4. A Relationship Between the Quality Dimensions and the Acceptability of the Device

An explanation of the relationship between the quality dimensions and the acceptability of the Innovated Wheel Cylinder Brake Leakage System of an Automotive at Iloilo State University. There are five attributes in collecting data such as Durability, Reliability, Conformity, Aesthetics, Safety and acceptability:

Table 13. A Relationship between the Quality Dimensions and the Acceptability

Variables	Quality Dimensions (x)	Acceptability (y)	X2	Y2	XY	r
Durability	4.568	4.47	20.87	59.94	8.99	
Reliability	4.57	4.47	20.88	59.94	8.99	
Conformity	4.55	4.47	20.70	59.94	8.99	
Aesthetics	4.52	4.47	20.43	59.94	8.96	
Safety	4.52	4.47	20.43	59.94	8.96	
Level of Acceptability on an Innovated Wheel Cylinder Leakage Tester	4.47	4.47	59.94	59.94	10.95	-7.91
Sum:	27.198	26.82	163.25	359.64	55.84	

Remarks:The correlation we obtained was – 7.91, showing us that there is a low negative correlation between quality dimensions and the acceptability of the device.

6. Conclusions And Recommendations

Based on the findings and after careful analysis and interpretation of the research study, it is concluded that the Innovated Wheel Cylinder Leakage System Model in Automotive: Technology Management meets the required standards and is the precise guide in Campuses Automotive Maintenance and for instructional device competencies.

It is recommended that the Innovated Wheel-Cylinder Leakage System Model in Automotive: Technology Management be adopted and practised for campus maintenance and automotive industries and instructional purposes.

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