Performance Level and Competency of the Automotive Students in Preventive Maintenance Servicing

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Abstract— This research aims to elevate the caliber of automotive technology programs at Sorsogon State University, with a keen focus on preventive maintenance to meet the evolving demands of the automotive industry. By scrutinizing the proficiency of third year students in automotive technology, particularly in vehicle preventive maintenance across specific mileage intervals (5,000, 10,000, 20,000, and 40,000 kilometers), the study assesses the alignment of educational outcomes with industry standards. The analysis revealed a predominance of 'Very Good' competency ratings among students, indicating a concentration of competence yet a scarcity of exceptional performance, suggesting the need for reassessment of evaluation criteria. Additionally, no significant correlation was found between students' self-assessment scores and their actual performance in preventive maintenance servicing, highlighting the limitations of self-assessment in vocational education settings. The research identifies critical areas for improvement in automotive preventive maintenance training, such as enhancing resources, increasing practical sessions, and reducing class sizes. The study underscores the necessity of curriculum reforms and the implementation of support mechanisms to better prepare students for the automotive industry. While focused on a specific institution and timeframe, the findings provide valuable insights into curriculum development and the potential for broader applicability in similar educational contexts.

Keywords— automotive students, competency, mileage, performance level, preventive maintenance servicing

I. INTRODUCTION

Automotive technology is essential for economic growth, particularly in the transportation sector, contributing significantly to GDP, exports, and economic activities (Stawiarska et al., 2021). Technological advancements in this sector influence innovation and customer experience, suggesting a focus on recent technologies to improve areas such as carsharing (Nansubuga & Kowalkowski, 2021). Addressing challenges like dependency on foreign technology and local supplier weaknesses through strategic policies is crucial for sustainable industry growth (Pollio & Rubini, 2019).

Industry 4.0 implementation is vital for the efficiency and competitiveness of automotive companies. Assessing their maturity in adopting these technologies can indicate their readiness for performance enhancement (Stawiarska et al., 2021). Furthermore, technology adoption at the firm level is crucial for value creation in the automotive sector (Minárik et al., 2022).

The automotive industry is transforming through Fourth Industrial Revolution concepts. Although a major global sector, automotive plants are adapting to technological advancements slower than anticipated, hindering the broader adoption of Industry 4.0 technologies (Pardi, 2019). Emerging trends like Servitization 4.0 and digital supply chain management are reshaping this ecosystem, highlighting the importance of sustainability and digital transformation (Jankovic-Zugic et al., 2023).

The automotive sector evolves due to global supply chain dynamics, necessitating strategic planning for industry competitiveness (Bell & Monaco, 2021). Innovations in technology are essential for growth in the automotive industry (Endler & Júnior, 2018). The Philippine automotive sector struggles with a shortage of skilled technicians. The sector's growth aligns with technological advancements, with continuous expansion in automotive product development expected (Andriyani et al., 2020). In job training centers, automotive courses face challenges related to curriculum, instructors, participants, management, facilities, budgets, government, and community support, with significant percentages indicating dissatisfaction across these areas (Sutiman et al., 2022).

The Philippines faces a shortage of skilled automotive technicians due to limited training programs in State Universities and Colleges (SUCs). To mitigate this, automotive companies need to either update or create new training initiatives, ensuring technicians are well-equipped with essential skills. The lack of adequate training equipment further worsens this issue. Enhancing training programs and incorporating hands-on experience with the latest technologies are vital for preparing technicians to perform preventive

maintenance effectively, thus enhancing vehicle safety and efficiency. Structured and standardized training programs are essential to bridge the education gap in the automotive sector, producing a more competent workforce (Cassano, 2012).

The discrepancy between the automotive industry's requirements and the training provided by educational institutions in the Philippines is a significant concern that necessitates immediate attention. The scarcity of proficient automotive technicians is compounded by the constrained capacity of State Universities and Colleges (SUCs) to deliver comprehensive automotive programs and the deficiency of adequate training equipment (Ezeama et al., 2017). Prospective technicians are not acquiring the necessary skills essential for preventive maintenance, a critical aspect for ensuring the secure and effective operation of vehicles.

To tackle this issue effectively, there is a crucial requirement to reevaluate the resources allocated to automotive training programs in the Philippines. By investing in updated training programs and granting access to modern equipment, educational institutions can better equip students for the demands of the automotive industry. The disparity between conventional training approaches and the evolving industry needs mandates a transition towards more practical, hands-on training that integrates the latest automotive technologies.

The Philippine educational system's misalignment with automotive industry needs is pronounced, notably in the shortage of skilled technicians. This gap is exacerbated by the limited capabilities of State Universities and Colleges (SUCs) in offering robust automotive programs and a lack of proper training equipment, hindering technicians' proficiency in essential preventive maintenance for safe vehicle operations (Ezeama et al., 2017).

To address this, it is vital to reassess and enhance the resources for automotive training in the Philippines. Investing in modernized training programs and equipment will better prepare students for the industry's demands. Additionally, transitioning to more practical, hands-on training that incorporates contemporary automotive technologies is essential to bridge the gap between traditional educational methods and current industry requirements.

To effectively address the automotive sector's skills gap, it is crucial to develop structured and standardized training programs tailored to industry demands (Renfro et al., 2020). Aligning training with industry standards ensures graduates are well-equipped for preventive maintenance tasks (Renfro et al., 2020). Collaborative efforts among educational institutions, industry stakeholders, and regulatory bodies are essential to create relevant training programs that enhance technicians' skills in the modern automotive landscape.

In the Philippines, most State Universities and Colleges (SUCs) are under-equipped for quality automotive technology education. To combat this, the government has initiated programs to elevate SUCs' automotive training quality, crucial for meeting industry and national demands for skilled workers (National Statistical Office of the Philippines, 2020). With vehicle production increasing by 26.4% in 2019, the demand for qualified automotive technicians is rising (National Statistical Office of the Philippines, 2020). An assessment of automotive technology programs in SUCs is necessary to ensure they meet industry needs and support the production of competent technicians.

The Philippine Society of Automotive Engineers (2018) reports a significant shortage of skilled professionals in the Philippines' automotive industry, attributing this to inadequate training and education in State Universities and Colleges (SUCs). Similarly, a study by the Commission on Higher Education underscores the necessity to improve automotive technology programs in SUCs, which currently lack the essential equipment, facilities, and qualified instructors. Ong (2017) further recommends a revision of the automotive technology curriculum in Philippine community colleges to keep pace with industry advancements. Rivera (2018) indicates that the industry's labor shortage stems from insufficient training in SUC automotive programs. Echoing this, Dacanay (2019) identifies a critical gap in skilled personnel within the industry, urging community colleges to update their training offerings to meet evolving industry needs. The Asian Development Bank (2019) suggests that the government invest in education and skills development to mitigate this shortage, highlighting the pivotal role of SUCs in providing relevant educational programs for the automotive sector.

Sorsogon State University in the Bicol Region hosted one of the highest-enrolled automotive technology programs, averaging 960 students annually. Despite a 40% employability rate among graduates in the national automotive industry, there was a need to assess and enhance the curriculum's effectiveness, particularly in

vehicle preventive maintenance. This research aimed to evaluate the competency levels of automotive students at the university in preventive maintenance services. By identifying the strengths and weaknesses of the current program, the study proposed improvements to better align the curriculum with industry demands, thereby increasing graduates' employability and ensuring they were well-prepared to meet contemporary challenges in the automotive sector. This alignment was crucial for bridging the gap between educational outcomes and industry requirements, fostering a workforce skilled in critical aspects of automotive technology.

Generally, this study aimed to determine the performance level and competency of the 3rd year automotive students in Preventive Maintenance Servicing (PMS) of the Sorsogon State University for the Academic Year 2023-2024. Specifically, it aimed to (1) describe the performance level of the automotive students in Preventive Maintenance Servicing; (2) determine the level of competency of the automotive students in Preventive Maintenance Servicing in terms of 5,000 kilometer, 10,000 kilometer, 20,000 kilometer, and 40,000 kilometer; and (3) challenges encountered by the automotive student in enhancing their competencies in Preventive maintenance Servicing.

II. METHODOLOGY

Research Design

The study employed a descriptive-correlational research design to analyze the competency and performance levels of students in the Preventive Maintenance Services (PMS) subject and to explore potential correlations between these two variables. The participants included third year students enrolled in the Automotive Technology program at the College of Technology during the 2023-2024 academic year. To assess student competency, a specifically designed self-assessment questionnaire on PMS was used, while performance levels were determined based on the students' course ratings from laboratory sessions. The data gathering process consisted of administering the competency questionnaire and conducting documentary analysis to collect performance data. The collected data were subjected to appropriate statistical analysis.

The Sample

The respondents of this study are 3rd year students that took up the PMS course and were enrolled in the Bachelor of Technology (BT) which specializes in Automotive Technology during the Academic Year 2023-2024. The numbers of respondents were the total enumeration comprising 210 regular students.

The Instruments

To collect the required data, a survey questionnaire served as the primary instrument for data collection.

The first survey instrument involves a self-assessment by students to gauge their competency level in Preventive Maintenance Service which is based on the industry standard. The assessment includes indicators tied to specific activities undertaken as part of PMS. For each indicator, students assess their skills using a scale that includes the following descriptors: poor, satisfactory, Very good, superior, and excellent.

The second survey instrument also centers on a self-assessment by students, focusing on the challenges they encountered during their PMS course. This questionnaire is structured into various sections, each addressing a different aspect of the learning experience, including Availability of Resource, Opportunities for Practical Activities, Support System, Self-Efficacy/Confidence among Students, Self-Motivation among Students, and Feedback & Improvement. Each section contains multiple indicators, which students evaluate based on their experiences throughout the course.

Prior to its official deployment, the questionnaires were subject to a pilot study in BT-VTED students who were taking the same specialization this 2nd second semester of 2024 with students enrolled in the same program, to assess the clarity and readability of the indicators.

Data Collection Procedures

Before the conduct of data collection with the actual respondents, the researcher sought a request letter to Campus Director of Sorsogon City campus and Dean of the College of Technology of Sorsogon State University to conduct a data collection among the said respondents.

To assess the academic performance of the students involved in this study, documentary analysis was employed, utilizing their final grades from the subject matter. These grades were then translated into qualitative descriptions following the evaluation scale outlined in the Student Handbook.

The crafted questionnaire was distributed to the study participants last March 25, 26 and 27, 2024. Participants were assembled in a classroom setting, where they completed the questionnaire simultaneously. This

instrument included sections for self-evaluation and identifying challenges faced during classroom lectures and laboratory sessions in the context of Periodic Maintenance Servicing (PMS). During the data collection process, any questions or uncertainties raised by participants regarding the survey items were promptly addressed to ensure clarity and accuracy of responses.

In instances where the questionnaire did not capture specific details relevant to a participant's experience, such information was recorded through unstructured interviews. This approach allowed for a more comprehensive understanding of the students' self-assessments and the obstacles they encountered in both theoretical and practical components of the program. Notably, the response rate for the questionnaire was 90% of the targeted respondent. This participation rate emphasizes the reliability of the study findings and enriches the insights regarding the academic experiences and challenges faced by the students. On the other hand, the remaining 10% which failed to be included in the data collection where those students that does not conduct the actual laboratory students, hence, they were the students that took the course online during the pandemic period.

Data Analysis Procedures

This study employed a range of statistical methodologies to meet its objectives. Specifically, the analysis of students' performance and competency levels was conducted using descriptive statistics, including weighted mean and frequency counts. Furthermore, the assessment of competency levels adhered to a uniform scale, with rating descriptions defined in accordance with the guidelines outlined in the SorSU Student Handbook.

Table 1. Competency Level Descriptions

Scale	Self-assessment Scores			
	20 points (5K)	30 points (10K)	40 points (20K)	50 points (40K)
Poor	1-4	1-6	1-8	1-10
Satisfactory	5-8	7-12	9-16	11-20
Very Good	9-12	13-18	17-24	21-30
Superior	13-16	19-24	25-32	31-40
Excellent	17-20	25-30	33-40	41-50

The competency level of the student is determined based on the scores they earn on their self-assessment questionnaire, which evaluates the skills they have developed in Preventive Maintenance Servicing (PMS)(Tzafilkou,et.al,2022; Vanckavičienė,et.al,2017, Menzala.et.al 2023). The self-assessment scores earned are categorized into different competency levels according to the distance covered by PMS's vehicles, with the mileage points ranging from 5K to 40K. The competency levels are divided into five categories: Poor, Satisfactory, Very Good, Superior, and Excellent, which these descriptions were adherent to the SorSu Student Handbook.

III. RESULTS AND DISCUSSION

1. Performance Level of Students in Periodic Maintenance Servicing

This data is taken from their laboratory grades in their Preventive Maintenance subject.

Table 2. Students' Performance Level (PL)

PL	Frequency (f)	Percentage (%)
Superior	4	1.9
Very Good	185	88.1
Satisfactory	21	10.0

This study's findings highlight a significant concentration of students rated 'Very Good' (88.1%) in their performance in the Preventive Maintenance Servicing subject, with notably fewer students achieving 'Satisfactory' (10.0%) or 'Superior' (1.9%) ratings.

Notably absent are ratings in the 'Excellent' category, with 'Passed/Poor' also unrepresented.

The presence of a large number of students in the 'Very Good' category may not solely indicate the success of a curriculum. While it could suggest alignment between course objectives and student abilities, it may not necessarily reflect the full picture. Additionally, Liu & Zhang (2023) highlighted that variations in course difficulty and ranking can impact student performance fairness, suggesting that performance outcomes may not solely be attributed to instructional methods. Moreover, Menéndez et al. (2019) emphasized the importance of formative assessment in understanding student performance. Formative evaluation, which involves continuous assessment during learning, provides insights into student progress and goal achievement. This aligns with the notion that a supportive educational environment, as suggested by the absence of lower performance ratings, plays a crucial role in ensuring student competence. Furthermore, Mcaloon et al. McAloon et al. (2020) demonstrated that a shift towards self-directed learning led to improved student performance, indicating that instructional methods focusing on autonomy and self-assessment can positively impact outcomes. This supports the idea that a combination of factors, including teaching strategies, student engagement, and assessment methods, collectively influence student performance.

2. Competency Level of the Automotive Students in Preventive Maintenance Servicing (PMS)

This data is taken from the result of the self-assessment questionnaire in Preventive Maintenance Service which is based on the industry standards.

Table 3. Competency Level of the Students in Various Mileage in PMS

Competency Level	5K		10K		20K		40K	
	f	%	f	%	f	%	f	%
Excellent	16	8	14	7	12	6	12	6
Superior	38	18	45	21	45	21	30	14
Very Good	80	38	79	38	71	34	75	36
Satisfactory	55	26	51	24	58	28	67	32
Poor	21	10	21	10	24	11	26	12

The table presents the summary of findings on competency level of the students on preventive maintenance servicing along various vehicles mileage. The results of their self-assessment were shown in Table 3.

a. 5,000 kms (5K) mileage

Upon reflecting on their self-assessment tied to the Preventive Maintenance Servicing (PMS) indicators at the 5,000-km interval, a significant 38% of the 210 students believe that the skills they learned were categorized as 'Very Good' based on the scores.

The positive self-perception observed in a cohort regarding their knowledge and understanding of Periodic Maintenance Servicing at an early stage could be attributed to effective foundational training or a novice's optimistic outlook before facing more complex scenarios (Sia et al., 2018). Such a positive self-perception could stem from an effective foundational training that builds initial confidence or a novice's optimistic view of their abilities before being tested by more complex scenarios.

This initial confidence is crucial as it sets a positive tone for the students' learning journey, providing a solid basis for their growth and development in the subject. It also reflects well on the introductory instructional methods, suggesting that these strategies successfully establish the core competencies required in the early stages of their education in PMS(Zhao, 2020).

A quarter of the students feel 'Satisfactory', while fewer consider themselves 'Superior' or 'Excellent'. A notable 10% feel 'Poor', indicating early recognition of the need for further learning. The instructional phase is crucial for establishing foundational concepts to support students in identifying gaps in their knowledge (Salcone, 2023). This phase is essential for laying the groundwork for further learning and interventions to support students who may already be recognizing deficiencies in their understanding . It is vital to ensure that students have the baseline competencies necessary for their educational journey (Piya et al., 2022). The findings underscore the importance of interventions to bridge any gaps in knowledge that students may have.

b. 10,000 kms mileage

Upon reaching the 10K milestone, the self-assessment profile changes marginally. The 'Very Good' category remains the most populous, yet there's a slight decline in the 'Superior' rating, while the 'Satisfactory' and 'Poor' ratings remain the same. This could indicate the onset of a re-alignment in self-perception as students dive deeper into the curriculum. Assessments play a crucial role in ensuring that instructional delivery remains consistent and that students who initially found the material challenging continue to be appropriately challenged (Zulfa & Ratri, 2022). The ongoing process of assessment is vital for monitoring students' learning achievements and ensuring their continued growth. While assessments are essential, challenges exist in measuring knowledge improvement accurately through post-assessment scores (Malhotra et al., 2022). There's a small decrease in the 'Excellent' category, suggesting that students are beginning to understand the increasing demands of competency in preventive maintenance as the course progresses.

c. 20,000 kms mileage(20K)

At this PMS indicators at this vehicle's mileage, the self-assessment results of the 34% of 210 students still dominated the category of Very Good based on their scores. However, the scores that fall under the category of Satisfactory slightly increase to 28% based on 10k mileage. In addition, students' scores that fall on Poor and Excellent category slightly increase and decrease, respectively. These results may suggest that the changes were due to recalibration of their understanding of the indicators between succeeding the vehicle's mileage for Preventive Maintenance Servicing. Instructionally, this suggests that the curriculum might be intensifying, or students are becoming more discerning in their self-assessment (Winter, et.al,2020). Furthermore, the increase in 'Poor' ratings could be attributed to a heightened awareness of the complexities involved in preventive maintenance or a possible disconnect between instructional methods and student

comprehension(Hudson, 2022). Additionally, explicit instruction has been found to align students' inferences with teachers' intentions, thereby increasing metacognitive awareness of lesson content (Fu, 2021)

d. 40,000 kms mileage(40k)

In examining the outcomes of self-assessment among students at a specific mileage point for Preventive Maintenance Service (PMS), a notable variation in self-evaluation was observed. Within a cohort of 210 students, 36% identified their performance as 'Very Good', an increase that may reflect a boost in self-confidence as they further their knowledge and expertise(Jiang,et.al., 2021). Conversely, 32% of students rated their performance as 'Satisfactory', indicating a significant portion of the cohort perceives room for improvement in their skill set. A decline in the number of students categorizing their performance as 'Superior' suggests that the complexity of the assessment criteria at this PMS milestone may be challenging(Vora, et.al,2018) . This observation could point to a critical examination period where students encounter the most rigorous aspects of their learning journey, possibly affecting their self-assessment outcomes. Moreover, the steady increase in 'Satisfactory' evaluations hints at a gradual refinement of skills among students, likely influenced by their engagement with the self-assessment process. This process appears to be instrumental in guiding students towards a realistic appraisal of their competencies and areas needing enhancement(Sarkar, et.al., 2021).

3. Challenges encountered by the automotive student in enhancing their competencies in Preventive maintenance Servicing

This data is based on the result of the survey in the challenges encountered by the students in their subject in Preventive Maintenance Service. These are the factors that hinder them to acquired full knowledge and skills in Preventive Maintenance Servicing.

Table 4. Challenges Encountered by the Students during their Course on PMS

Indicators	Percentage (%)	Rank
Availability of Resources Access to necessary tools and equipment for all students is restricted due to limited quantities or resources.	88	1
Opportunities for Practical Activies The number of practical sessions included in the curriculum is insufficient for mastering preventive maintenance skills.	86	2

Necessity of Feedback and Support Need regularly feedback on my preventive maintenance tasks from instructors or peers.	84	3
Adequacy of Instructional Materials Lack of instructional materials such as repair manuals or learning modules that will serve as a guide during practical activities.	65	4
Adequacy of Instructors Guidance Instructors are not always available for extra guidance, feedback, or support outside of scheduled class times.	46	5
Academic Pressure The volume of coursework, including theoretical studies and practical assignments, is excessive, leading to stress.	37	6
Learning Environment The learning environment is not supportive and do not foster my growth in preventive maintenance.	35	7
Self-Motivation among Students Lack of strong interest in automotive studies, especially in preventive maintenance.	32	8
Self-Efficacy/Confidence among Students Lack of self-confidence to perform preventive maintenance tasks effectively.	31	9

The respondents in this study identified several challenges encountered during their PMS course. The most significant issue, reported by 88% of respondents, was availability of resources in laboratory sessions. Following this, 86% of respondents noted a lack of opportunities for practical activities to conduct PMS procedures. Additionally, 84% highlighted insufficient feedback on their tasks and lack of support from peers. These challenges significantly impacted their learning experience and overall competency development.

The identified challenges have significant implications for the effectiveness of the PMS course. Availability of resources hinders students' ability to practice and master necessary skills, leading to lower competency levels. The lack of opportunities for practical activities and insufficient feedback further restrict students' practical learning and development.

The challenges in the Vehicle's Preventive Maintenance Servicing course have significant implications for academic institutions. Availability of resources, lack of opportunities for practical activities, and inadequate feedback hinder students' practical learning and skill development (Wang, 2023). This highlights the need for institutions to invest in better resources, increase practical sessions, and enhance feedback systems.

Research emphasizes the importance of preventive maintenance for vehicle safety and cost reduction, underscoring the necessity for comprehensive training in academic programs. Integrating advances in predictive maintenance, supported by machine learning,

is crucial for effective vehicle servicing and should be part of the curriculum (Jain et al., 2022).

Institutions should incorporate high-quality preventive maintenance training to better prepare students for professional practice (James et al., 2020). Including the latest technologies and methods, such as condition monitoring systems and predictive maintenance, ensures students receive relevant education (Tsunashima & Hirose, 2020).

To address these challenges, academic institutions should adopt advancements like edge computing and predictive maintenance to improve teaching practices and student outcomes (Abdullah et al., 2022). Decision support systems can guide students through maintenance actions in predictive maintenance scenarios (Aiello et al., 2020).

IV. CONCLUSON AND RECOMMENDATIONS
This study concluded that most individuals are rated 'Very Good,' with few 'Satisfactory' or 'Superior,' and none 'Excellent' or 'Passed/Poor.' This suggests exceptional performance is rare, indicating a need to re-evaluate assessment criteria to better differentiate performance levels and identify improvement areas. Students' competency levels in Preventive Maintenance Service (PMS) remain consistently 'Very Good' across various milestones, with only minor adjustments in other performance categories.

It was recommended that reassess and refine the evaluation criteria to better differentiate performance

levels and recognize exceptional achievements, aiding in more targeted development strategies. To enhance PMS student performance, focus on areas with minor variations and develop targeted improvement strategies to elevate competencies to a 'Very Good' level, ensuring uniform excellence and comprehensive educational outcomes.

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