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Research Article

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# Development of Indicators on Automotive Technology Skills of Vocational Diploma Students: A Confirmatory Factor Analysis Model

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***Abstract***

*The present research was aimed to develop indicators on automotive technology skills and compare automotive technology skills of vocational diploma students among type of educational institutions. A stratified random sampling method was used to select a sample of 400 from the population of 1,337 second year vocational diploma students in Auto Mechanic Department under the Office of Vocational Education Commission in Samutprakan, Nonthaburi, Phathumthani, Saraburi, and Ayutthaya. The research instrument was a 5 rating scale questionnaire with a reliability of 0.956. The data analysis were first order a confirmatory factor analysis, mean, standard deviation, and one-way ANOVA. The findings were as followed. (1) The indicators on automotive technology skills of vocational diploma students comprised 20 indicators, is valid and fit to empirical data i.e. Chi-square = 98.314, df = 81, p = 0.093, GFI = 0.987, AGFI = 0.965, and RMSEA = 0.017. (2) The automotive technology skills of vocational diploma students among type of educational institutions were not different at a significance level of .05 .*

***Keywords:*** *Indicators; Automotive Technology Skills; Vocational Diploma Students*

## 1. Introduction

To develop a country within this global context, it must be driven by innovation and creativity, along with the skills necessary for workers within a 21st Century environment (Reeve, 2014, 2016).

The importance of the vocational education system for Thailand cannot be understated as Thailand advances into the Fourth Industrial Revolution (4IR) which Thai policy makers have labeled as Thailand 4.0 (Jones & Pimdee, 2017). Thailand 4.0 is an economic model based on high-level services, innovation, new technology, and creativity (Baxter, 2017).

According to a UNESCO (2015) study, a key challenge for Technical Vocational Education and Training (TVET) in Thailand is the ability to provide a sufficient number of highly qualified and well-trained technicians to respond to the needs of the rapidly changing economy. To meet these challenges, Thailand in 2015 enrolled 318,500 vocational education students, which was an 86,052-student increase compared to the same period in 2014 (Mala, 2015). In 2017, Thailand graduated 400,000 bachelor's degree students, along with 140,000 vocational education graduates, which entered Thailand's workforce (Board of Investment, 2017). The development of thought is one of the approaches that will improve the quality of the learners. Practicing thinking skills and thinking processes are of significant factors in developing the learners' intelligence (Sindhvananda,

2013). In Thailand however, studies and scholars have noted that TVET (technical and vocational education and training) has not been able to provide sufficient highly-qualified and well-trained technicians for a rapidly changing economy (UNESCO Bangkok, 2011).

When it comes to maintaining a competitive edge, specialist training is crucial in the automotive industry. In Thailand, vocational education has been identified as a key component for this training under a new 20-year educational plan in which the current ratio of vocational students to general curriculum students will increase from 38:62 to 60:40 (Mala, 2018; Sermsirikarnjana, Kiddee, & Pupat, 2017). Furthermore, Thailand's Vocational Education Act B.E. 2551 emphasized the provision of vocational education and professional training in line with the National Economic and Social Development Plan. The approach to education provision was defined in three schemes including formal education, non-formal education, and bilateral education. The Office of the Vocational Education Commission (OVEC) is the main body whose mission is the management of vocational education and professional training to develop the skilled, technical, and technological manpower to meet the demand of labor market (Ratchusant, 2009).

OVEC accordingly implements policy to enhance skilled manpower and prepare the target groups by equipping them with required competencies with international standards to correspond with the restructuring of Thailand's economy and industry. As the competition is high for the skills which can produce goods and services of quality and quantity which meet production time, the vocational management system has followed a "Demand Driven" development style under mutual collaboration with educational institutions and business establishments (UNEVOC, 2009). The educational provisioning process for entering a career, life or a profession involves the production and development of manpower at all levels of semi-skilled, skilled, and technician with the quality and standards that satisfy the demand of the labor market and self-employment (Office of the Vocational Education and Professional Standards, 2009).

Skills development in the labor sector of a country is at the heart of national development, particularly in a developing country like Thailand where laborers are needed in various sectors including agriculture, industry, and service businesses. Countries, enterprises and persons all perceive skills development as strategic, and consequently seek to step up investments in skills (ILO, 2010). Skills development attempts to solve skills' problems of the labor force in order to support and catch up with technological changes so that they can perform effectively using required standards and satisfy the need of the labor market (Department of Skills Development, 2013).

Given the above current trend, the author is thus interested in developing indicators of automotive technology skills and comparing these skills amongst various Thai vocational college students studying under OVEC. These indicators can be used to prepare vocational manpower planning and development, practice skills, problem solving skills, and actual work skills, by which students adapt themselves to automotive industry changes and technological innovations. The outcome therefore is meeting the real needs of business establishments and communities.

## 2. Purposes of the Study

This research on automotive technology skills of vocational diploma students under the OVEC seeks to develop indicators on automotive technology skills and compare these skills between multiple Thai vocational institutions. The research questions identified were as follows.

1. Do the automotive technology skill indicators of vocational diploma students under OVEC authority fit the empirical data?
2. Are there differences in the indicators between the various educational institutions for their students?

## 3. Conceptual Framework

For this research, the author undertook a documentary synthesis from the following documents which included the Higher Vocational Certificate Curriculum B.E.2536 (1993) for Industrial Techniques Program in Auto Mechanics, the Higher Vocational Certificate Curriculum B.E.2540 (1997) for Industrial Techniques Program in Auto Mechanics, and the Higher Vocational Certificate

Curriculum B.E.2546 (2003) for Industrial Techniques Program in Mechanics (OVEC, 2016). From the commercial automotive sector, the author adopted the Automotive Technological Toyota College Handbook (Toyota Motor Thailand, 2017).

The author also conducted interviews with five experts and instructors under OVEC including Rajasitharam Technical College, Bangkok, Pathumthani Technical College, Pathumthani Province, Ayutthaya Automotive Industry Technical College, Ayutthaya Province, Maharaj Industrial and Community Education College, Ayutthaya Province, and Chonburi Technical College, Chonburi Province. Interviews were also conducted with five technicians working at Toyota Paragon Motor Co. Ltd., PPS Autotrade Co. Ltd., Nissan Kwang Thai Automobile Co. Ltd., Thanyaburi Honda Cars Co. Ltd., and Kow Yoo Hah Isuzu Sales Co. Ltd. In conclusion, the following four main areas were identified for evaluation:

1. Maintenance and Repair of Engine System
2. Maintenance and Repair of Electric System
3. Maintenance and Repair of Transmission System
4. Maintenance and Repair of Suspension System

## 4. Research Hypotheses

Does the automotive technology skills indicators of vocational diploma students developed by the researcher fit the empirical data?

Are there noticeable differences between vocational diploma students at different colleges who are involved in automotive technology skill programs?

## 5. Research Methodology

### *5.1 Population and Sample*

The population included 1,337 second year vocational diploma students enrolled in an Auto Mechanic Department under OVEC authority in the provinces of Samutprakan, Nonthaburi, Phathumthani, Saraburi, and Ayutthaya. The sample consisted of 400 second year vocational diploma students enrolled in an automotive maintenance program (Hair, Black, Babin & Anderson, 2010). The sample was obtained by a process of stratified random sampling.

**Table 1.** Sizes of population and sample, classified by types of educational institution

| Types of educational institution | Population (students) | Sample (students) |
|---|---|---|
| Technical | 760 | 225 |
| Vocational College | 308 | 95 |
| Polytechnic College | 269 | 80 |
| Total | 1,337 | 400 |

### *5.2 Research Instrument*

A questionnaire concerning the automotive technology skills of vocational diploma students was used which contained 2 parts. Part 1 was concerned with information about the respondents' characteristics and type of educational institution. Part 2 contained 20 items rated on a 5-level Likert type agreement scale (Likert, 1967). Content validity was evaluated by use of the Index of Item-Objective congruence (IOC), which was from 0.60 - 1.00, and reliability with Cronbach's Alpha Coefficient was .956.

### *5.3 Data Collection*

All questionnaires were personally collected by the researcher from the sample of second year vocational diploma students in Auto Mechanic Department under the Office of Vocational Education

Commission.

### *5.4 Data Analysis*

A confirmatory factor analysis was employed using the criteria of Chi-square, GFI, AGFI, RMSEA, One-Way ANOVA, mean and standard deviation.

## 6. Results

List of symbols in the research

| | | |
|---|---|---|
| $\bar{X}$ | = | Mean |
| S.D | = | Standard Deviation |
| RMSEA | = | Root Mean Square Error of Approximation |
| GFI | = | Goodness of Fit Index |
| AGFI | = | Adjusted Goodness of Fit Index |
| Skill | = | Automotive technology skills of vocational diploma students |
| (X1) | = | Changing engine oil and oil filter |
| (X2) | = | Changing benzene fuel filter |
| (X3) | = | Changing diesel fuel filter and bleeding out diesel filter air |
| (X4) | = | Connecting Ignition System Circuit |
| (X5) | = | Setting Ignition Timing with Timing Tool |
| (X6) | = | Checking & Refilling, Changing Coolant |
| (X7) | = | Changing and Adjusting Belt Tension |
| (X8) | = | Changing Fuses and Signal Lamp |
| (X9) | = | Checking and Refilling Distilled Water |
| (X10) | = | Changing Battery |
| (X11) | = | Checking and Bleeding Clutch |
| (X12) | = | Checking and Changing Transmission Oil |
| (X13) | = | Checking and Disassembling/Assembling Propeller Shaft |
| (X14) | = | Checking and Changing Differential Oil |
| (X15) | = | Checking and Disassembling/Assembling Brake System |
| (X16) | = | Changing and Bleeding Brake System |
| (X17) | = | Checking and Disassembling/Assembling and Adjusting Steering System |
| (X18) | = | Checking and Disassembling/Assembling Chock Up |
| (X19) | = | Checking and Disassembling/Assembling Shackle |
| (X20) | = | Tyre System Check and Service |

Table 2 displays the correlations of 20 observed variables of indicators on automotive technology skills of vocational diploma students. The Bartlett's Test of Sphericity determined whether the correlation matrix of observed variables is of identity matrix. The analysis results showed that Chi-square = 6465.996, df = 190, and p = 0.000 and also agreed to the analysis results of Kaiser-Meyer-Olkin (KMO) index of Measure of Sampling Adequacy of 0.914 which is closer to 1. This suggested that the correlation matrix of observed variables is not of identity matrix and strong correlations between variables were found. Furthermore, Figure 1 shows the results of indicators on automotive technology skills of vocational diploma students suggesting that the model fit the empirical data, with $X^2$ = 98.314, df = 81, p-value = 0.093, GFI = 0.987, AGFI = 0.965, and RMSEA = 0.017.

**Table 2.** Values of correlation coefficient of indicators on automotive technology skills of vocational diploma students

| Observed Variables | Correlation Coefficient | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 | X15 | X16 | X17 | X18 | X19 | X20 |
| X1 | 1.000 | | | | | | | | | | | | | | | | | | | |
| X2 | .580 | 1.000 | | | | | | | | | | | | | | | | | | |
| X3 | .380 | .515 | 1.000 | | | | | | | | | | | | | | | | | |
| X4 | .164 | .300 | .447 | 1.000 | | | | | | | | | | | | | | | | |
| X5 | .248 | .270 | .406 | .517 | 1.000 | | | | | | | | | | | | | | | |
| X6 | .430 | .423 | .394 | .269 | .261 | 1.000 | | | | | | | | | | | | | | |
| X7 | .342 | .472 | .474 | .256 | .279 | .422 | 1.000 | | | | | | | | | | | | | |
| X8 | .396 | .391 | .354 | .301 | .210 | .363 | .405 | 1.000 | | | | | | | | | | | | |
| X9 | .393 | .387 | .332 | .216 | .088 | .344 | .335 | .548 | 1.000 | | | | | | | | | | | |
| X10 | .427 | .388 | .331 | .240 | .150 | .396 | .348 | .469 | .624 | 1.000 | | | | | | | | | | |
| X11 | .313 | .379 | .400 | .312 | .253 | .371 | .459 | .268 | .348 | .266 | 1.000 | | | | | | | | | |
| X12 | .321 | .431 | .430 | .282 | .124 | .403 | .536 | .305 | .399 | .441 | .500 | 1.000 | | | | | | | | |
| X13 | .241 | .395 | .481 | .327 | .257 | .335 | .364 | .345 | .410 | .388 | .478 | .530 | 1.000 | | | | | | | |
| X14 | .385 | .435 | .413 | .316 | .143 | .406 | .432 | .336 | .421 | .537 | .444 | .550 | .591 | 1.000 | | | | | | |
| X15 | .381 | .325 | .355 | .285 | .165 | .301 | .350 | .299 | .361 | .315 | .385 | .441 | .386 | .364 | 1.000 | | | | | |
| X16 | .364 | .404 | .408 | .224 | .161 | .288 | .384 | .334 | .400 | .421 | .469 | .525 | .423 | .462 | .481 | 1.000 | | | | |
| X17 | .212 | .270 | .427 | .427 | .400 | .312 | .324 | .276 | .200 | .190 | .333 | .311 | .373 | .323 | .328 | .413 | 1.000 | | | |
| X18 | .327 | .411 | .403 | .446 | .285 | .361 | .297 | .276 | .315 | .305 | .284 | .326 | .412 | .403 | .344 | .446 | .501 | 1.000 | | |
| X19 | .316 | .399 | .382 | .336 | .278 | .308 | .460 | .326 | .382 | .446 | .332 | .469 | .495 | .432 | .366 | .482 | .415 | .480 | 1.000 | |
| X20 | .285 | .327 | .417 | .448 | .311 | .391 | .366 | .409 | .404 | .358 | .357 | .341 | .376 | .435 | .401 | .407 | .465 | .431 | .390 | 1.000 |
| KMO: Measure of Sampling Adequacy = 0.914 Bartlett's Test of Sphericity: Chi-square = 6465.996 , df = 190 , p = 0.000 | | | | | | | | | | | | | | | | | | | | |

### *6.1 Results of validity of the indicators*

Figure 1 shows the indicators and their results of automotive maintenance student skills.

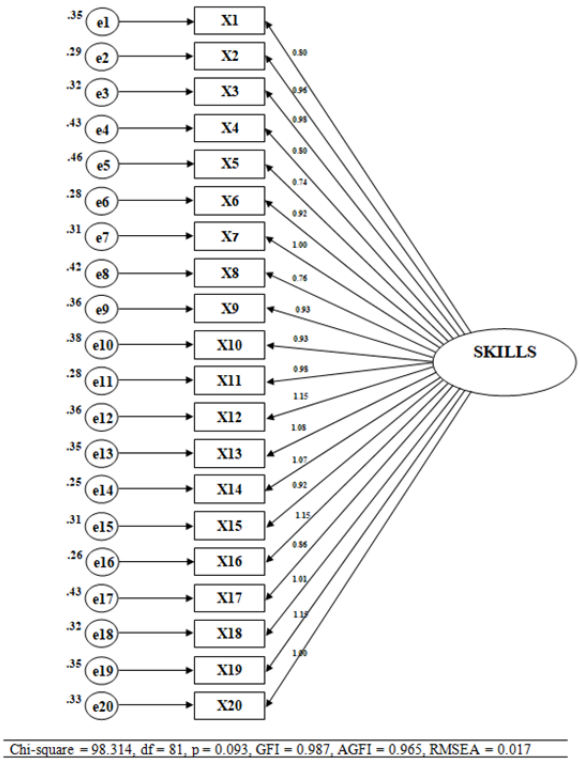


**Figure 1.** Model on Automotive Technology Skills of Vocational Diploma Students

### *6.2 Results of comparison of automotive technology*

Table 3 shows the mean and standard deviation results for student automotive technology skills. As suggested in Table 3, the automotive technology skills of vocational diploma students were at a high level overall ($\bar{X}$ = 4.20, S.D. = 0.45), and at a high level for each sub-skill of automotive technology. The top three highest mean values were for maintenance and repair of electric systems ($\bar{X}$ = 4.33, S.D. = 0.61), followed by maintenance and repair of transmission systems ($\bar{X}$ = 4.22, S.D. = 0.57), and maintenance and repair of engine systems ($\bar{X}$ = 4.18, S.D. = 0.48), respectively.

**Table 3.** Mean and standard deviation of automotive technology skills

| Automotive Technology Skills | Technical College ( n = 400 ) | | Vocational College ( n = 400 ) | | Polytechnic College ( n = 400 ) | | Overall ( n = 400 ) | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. |
| Maintenance and Repair of Engine System | 4.20 | 0.53 | 4.22 | 0.49 | 4.15 | 0.49 | 4.18 | 0.48 |
| Maintenance and Repair of Electric System | 4.35 | 0.61 | 4.36 | 0.59 | 4.30 | 0.61 | 4.33 | 0.61 |
| Maintenance and Repair of Transmission System | 4.25 | 0.55 | 4.20 | 0.58 | 4.21 | 0.58 | 4.22 | 0.57 |
| Maintenance and Repair of Suspension System | 4.20 | 0.47 | 4.15 | 0.55 | 4.14 | 0.52 | 4.16 | 0.53 |
| Total | 4.23 | 0.44 | 4.22 | 0.46 | 4.18 | 0.45 | 4.20 | 0.45 |

The automotive technology skills of technical college students were at a high level overall ($\bar{X}$ = 4.23, S.D. = 0.44), and at a high level for each sub-skill of automotive technology. The top three highest mean values were for maintenance and repair were for electric systems ($\bar{X}$ = 4.35, S.D. = 0.61), followed by maintenance and repair of transmission systems ($\bar{X}$ = 4.25, S.D. = 0.55), and maintenance and repair of engine systems ($\bar{X}$ = 4.20, S.D. = 0.47), respectively.

The automotive technology skills of vocational college students were at a high level overall ($\bar{X}$ = 4.22, S.D. = 0.46), and at a high level for each sub-skill of automotive technology. The top three highest mean values were for maintenance and repair of electric systems ($\bar{X}$ = 4.36, S.D. = 0.59), followed by maintenance and repair of engine systems ($\bar{X}$ = 4.22, S.D. = 0.49), and maintenance and repair of transmission systems ($\bar{X}$ = 4.20, S.D. = 0.58), respectively.

The automotive technology skills of polytechnic college students were at a high level overall ($\bar{X}$ = 4.18, S.D. = 0.45), and at a high level for each sub-skills of automotive technology. The top three highest mean values were for maintenance and repair of electric systems ($\bar{X}$ = 4.30, S.D. = 0.61), followed by maintenance and repair of transmission systems ($\bar{X}$ = 4.21, S.D. = 0.58), and maintenance and repair of engine systems ($\bar{X}$ = 4.15, S.D. = 0.49), respectively.

Table 4 shows that overall, there was no difference of automotive technology skills among vocational diploma students of technical colleges, vocational colleges, and polytechnic colleges.

**Table 4.** Comparison results of automotive technology skills of vocational diploma students by types of educational institutions using One-Way ANOVA

| Automotive Technology Skills | Source of Variance | SS | df | MS | F | Sig. |
|---|---|---|---|---|---|---|
| 1. Maintenance and Repair of Engine Systems | Between Groups | .524 | 2 | .262 | 1.109 | .331 |
| | Within Groups | 140.007 | 592 | .236 | | |
| | Total | 140.532 | 594 | | | |
| 2. Maintenance and Repair of Electric Systems | Between Groups | .368 | 2 | .184 | .493 | .611 |
| | Within Groups | 221.186 | 592 | .374 | | |
| | Total | 221.555 | 594 | | | |
| 3. Maintenance and Repair of Transmission Systems | Between Groups | .216 | 2 | .108 | .325 | .723 |
| | Within Groups | 196.805 | 592 | .332 | | |
| | Total | 197.021 | 594 | | | |
| 4. Maintenance and Repair of Suspension Systems | Between Groups | .353 | 2 | .176 | .615 | .541 |
| | Within Groups | 169.694 | 592 | .287 | | |
| | Total | 170.046 | 594 | | | |
| Total | Between Groups | .226 | 2 | .133 | .635 | .531 |
| | Within Groups | 123.974 | 592 | .209 | | |
| | Total | 124.240 | 594 | | | |

## 7. Discussion

The research results of indicators on automotive technology skills of vocational diploma students under OVEC are discussed as follows.

The analysis results of indicators displayed a construct validity as those 20 indicators of automotive technology skills were determined by the fit index as shown by p-value = 0.093. It is also consistent with the Higher Vocational Curriculum B.E. 2546 (2003) which aims to equip vocational graduates with the skills and competencies which meet professional standards. The criteria of the curriculum stipulates that individuals who graduate from a course are required to pass the professional standards assessment of their particular field of study (Office of the Vocational Education Commission, 2009).

Puechpan (2015) suggested that students enrolled in vocational diploma automotive maintenance programs in Chonburi Province, should make use of Thailand's national vocational qualifications framework as it better serves the needs of prospective employers and enterprises.

Furthermore, the development of study skills plays a significant role in students' academic performance in the learning process, with study skills important in judging students' overall potential and attainment levels (Naqvi, Chikwa, Menon, & Kharusi, 2018).

The results from the comparison of the three types of vocational colleges which enrolled automotive technology students showed that for vocational diploma students of technical colleges, vocational colleges, and polytechnic colleges, their overall automotive technology skills in maintenance and repair of engine systems, maintenance and repair of electric systems, maintenance and repair of transmission systems, and maintenance and repair of suspension systems, were not different at a significance level of .05. This suggests that vocational diploma students of each institution have similar levels of automotive technology skills.

Also, according to Wiriyaprakob (1999) on the implementation of Vocational Certificate Curriculum 2538 B.E. in Auto-mechanics in the Technical College Division and Vocational College Division under the Department of Vocational Education in the Eastern area, it was suggested that it is the mission of educational institutions and vocational organizations to manage and change their curriculum to support the labor market so that students will possess knowledge, good skills and competencies at work.

## 8. Implications for Action

The results of investigation on automotive technology skills of vocational diploma students indicated that students from polytechnic colleges had the lowest level of skill in the maintenance and repair of suspension systems.

## 9. Further Study

Further studies should offer the development of training course on automotive technology skills enhancement for vocational diploma students in order to help improve the desirable skills.

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