

New Skill Demand of Automotive Technology In Vocational Education And Training on The Background of AI In Ethiopia

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Abstract: - The purpose of this research was to assess the existing integration level of AI technologies in Automotive technology curriculum of vocational education and training as well as to suggest courses which facilitate the integration of AI with this major. Qualitative research method was employed to analyse the interview results and literatures related to vocational education and training, and AI application in automotive industries that increase the quality requirement of VET graduates of automotive technology. Interview was conducted from four stakeholders namely; educational policy officers, employers, teachers and directors, and students/graduates. This qualitative data was imported to MAXQDA 2020 software for analysis. The result showed that as there is no integration of AI in-vehicle application content in automotive technology training curriculum of vocational education and training of Federal Democratic Republic of Ethiopia. Teachers of vocational education and training have knowledge and skill gap on

contemporary technologies used in vehicle systems which in turn left huge in students learning. Courses from fundamental disciplines like software engineering, computer science, mathematics, electrical engineering and mechanical engineering were suggested to be incorporated in the curriculum. In addition, information technology, English, computer programming, electric and electronics, automotive related software, basic AI in vehicle application, electronic fuel injection system, electric vehicle, sensor, actuator, animation and simulator training are the specific courses which can enhance the quality of graduates relative to the needs of automotive industries.

Keyword: Artificial intelligence, Education, Automotive technology, Curriculum

1. INTRODUCTION

In these days, rapid pace of use of artificial intelligence has impacted vocational education and training systems incredibly hard. Artificial intelligence has become the driving force of technology and will be in the future. For this reason, governmental organizations and companies around the world are putting huge amount of money to ensure widespread production and application of AI.

Artificial intelligence has brought tremendous changes in many fields such as electrical, mechanical, automotive, medical and computer fields as well as

educational institutions. It compels vocational colleges especially automotive to make corresponding changes to catch and stride with the rapid development of this technology. Artificial intelligence is multi-disciplinary subject which encompass wide range of disciplines. It is a technological science which is researching and developing machine intelligence based on human intelligence through simulation, extension and expansion (Han, Yiqiang 2020) [7]. AI represents machine or system which has an intelligence like human intelligence thereby can process tasks and solve

problems without human interference (Roppertz, Sophia 2020 [18], Koricanac, Igor. 2021 [12] and V. Pujari et 2021 [19]).

As urbanization and demand of mobility increases the number of vehicles running on the road increases. The advancement of information and communication technology and robot technology has changed automotive industry production and service jobs. Now a days, vehicles are becoming more advanced with artificial/smart technologies where driving, vehicle production process, selling and maintenance service works are accomplished with advanced tools and machines with the control of highly skilled workers. Based on the advancement of AI in the vehicle system, there are different level of driving automation are available in the market. Due to the advancement of technologies in the vehicle system, employers have put strict human labour requirements as a result employees only with high professional quality and high comprehensive skill would be selected.

Ethiopia has begun a process of reforming TVET system and its policies to facilitate technology transfer by taking aboard experiences and adapting it in Ethiopian context. Great emphasis is given to TVET because of the role it plays with regard to technology transfer capabilities. The current TVET curriculum is outcome-based and Ethiopian occupational standard is the responsible body which defines the occupational requirements and expected outcomes. Occupational standard comprises of unit of competence which describes distinct work activity. National TVET Qualification Framework classified program title into levels of competence which takes 1-4 years based on the program level. According to Geleto, Lemecha (2018)[5], Ethiopian TVET was curriculum and input based before the launch of new TVET strategy in 2006. The author described this curriculum pre-2006 was with no occupational standards, quality of training was by completion of curriculum content and determination of occupation was mainly by ministry of education. However, the curriculum needs to be more flexible with respect to content organization, structural organization and contemporary technologies related to a particular field. In this era, occupational standards are changing rapidly due to technology and innovation especially the wide spread use of AI. According to Cheng, Yunli, and Xu Bu (2020) [3], artificial intelligence is already in a period of unprecedented development which entirely change people's life. The author stressed that each country requires corresponding artificial intelligence education. However, there is no clear systematic discussion still how artificial intelligence education is going to be in vocational education. The existing vocational education and training curriculum as well as instructional method is not able to cope rapid changes made in the industries resulting the need of restructuring and organization

of automotive technology curriculum in TVET with core courses and AI related supplementary courses. The cross integration of disciplines ensures the cultivation highly skilled and comprehensive talented graduates of workplace jobs.

In the traditional automotive industry service and production lines, graduates from vocational college were the right choice to get the job done no matter how much the graduate knows about artificial intelligence and its purpose. However, as the innovation and demand of modernizing of industries increases, the connotation of using artificial intelligence has emerged in unbelievable rate. Vocational education and training have to bear the impact of artificial intelligence on employment, instructional method and make graduates meet the requirements to new employment changes. Therefore, vocational education needs to improve the quality of graduate's competence by strengthening the teaching staff capability, enhance cooperation of enterprises, provide adequate training and internship, changing teaching models and curriculum contents (Hui, Feng, 2020) [9]. Vocational schools faced two challenges in the context of the digital transformation; preparing youths for a technology-based working world and transforming vocational education institutions to contemporary technology learning (Roppertz, Sophia 2020) [18]. To introduce artificial intelligence technologies in automotive major of vocational education and training there has to be well integrated curriculum structure, talent training plan, teaching resources and students with good abilities. All rounded/integrated curriculum helps the students not to be myopic. It would lighten their way of learning useful knowledge beyond the boundary of their major as a result they can solve associated problems from other fields. In other words, VET institutions should make the necessary reform according to the actual technology changes in automotive industry to bring better fit to the labour requirements thereby employability and innovation can be improved.

Companies these days require skilled and knowledgeable VET automotive major graduate with fundamental know how of contemporary technologies. Therefore, the current automotive mechanic curriculum has to be redesigned under the consideration of integration AI application in automotive industry. By doing so, employment posts of automotive industries, standards and national policies can be satisfied. The existing automotive technology curriculum is not able to emulate rapid changes of automotive industries. Therefore, the curriculum needs to be reconstructed with some core courses which facilitate to apprehend artificial intelligence technologies in vehicle systems and integrate different disciplines to cultivate highly skilled and comprehensive talented graduates. In an ever-changing world, automotive mechanics have to improve their

understanding of new technologies and innovations related to vehicles so as to perform tasks flawlessly. This work explored the integration of artificial intelligence with automotive technology of TVET in Ethiopia and describes the research result of the current integration level of AI with the existing curriculum and the course content to be incorporated to the Vocational Education and Training

Education is a formal activity through which knowledge and skill transmit with an ultimate goal of preparing people for world of work. Vocational education is alternatively referred as technical and vocational education and training, occupational education and technical education. Vocational education is intended to train learners with skills and knowledge required by the industries. In other words, it is an education system that prepares students to real world of work in a particular field. Most of vocational education program is short, and students receive diploma certificate after completion. It empowers individuals, enterprises and communities thereby promote sustainable economic growth and competitiveness in the world of work. Literally, graduates of vocational college is one of the important force in building national development. Rageth, Ladina, and Ursula Renold (2019) [17] defined “vocational education as an educational system which aims to prepare learners for specific occupation with the required skill, knowledge and competences as well as for further education and career development”. Vocational education is formal and informal learning that prepares students with skills and knowledge required at workplace. TVET has been referred by many names over the years such as vocational education, technical education, apprenticeship training, vocational education and training, professional and vocational education, occupational education, career and technical education, workforce education, and workplace education. However, TVET has been common name that involves the study of technology and related sciences, according to Jabarullah, Noor H., and Hafezali Iqbal Hussain (2019) [10]. TVET provides participants to acquire skills, knowledge necessary for employment in a particular occupation or occupations (Geleto, Lemecha 2018) [5].

Vocational school must be able to anticipate changes and developments in the world of work in the era of AI and industrial revolution 4.0 as it is today. The industrial revolution has changed the work process which emphasizes effectiveness and efficiency.

Vocational education reform needs based on the development of artificial intelligence

Vocational education and training has to transform its training contents based on workplace jobs. Occupations in

curriculum to the anticipated contemporary curriculum by conducting interviews to different stakeholders as well as with direct observation and from literatures. Qualitative analysis has been employed with the help of MAXQDA 2020.

industries have been changed due to the application and development of AI. Yang, Shuai, and Haicheng Bai (2020) [21] claimed, deep integration of artificial intelligence with education will be the main trend of educational development in the future of intelligence. It is key to cultivate innovative talents in the background of artificial intelligence to build teachers for tomorrow. The current problems like student learning characteristics and teacher’s quality can be solved by designing integration model of artificial intelligence and education. It was concluded that effective implementation of integration would establish strong relationship between college and enterprise as well as improve innovative ability of artificial intelligence products. Holmes, Wayne et al (2019) [8] reported that courses are now replaced and departments have been recombined to offer courses related to big data analysis, cloud computing and internet of things to meet the demands of industry. Vocational schools should precisely design vocational education courses according to future graduates’ new work fields and opportunities. Han, Yiqiang (2020) [7] suggested that the curriculum needs to integrate the needs of intelligent production horizontal integration of courses in the same professional field, cross-border integration of courses in different professional fields, and training students to have overall and comprehensive professional ability. Zhou, Yuehong et al (2020) [23] described that with close cooperation of school and enterprise the company's real project can be transformed into the carrier of artificial intelligence professional course teaching project, which can make the teaching vivid through learning by doing and doing by learning. Ma, Jinhua (2019) [16] suggested the way of transform is by adding large data and artificial intelligence courses and contents to the existing professional curriculum system of vocational education, as well as reconstructing resources, library and establishing a hierarchical and modular training system. The author concluded that according to the needs of vocational skills, core curriculum series related to AI should be added as vocational education is committed to training high-tech application-oriented talents, integrate industry and education, and integrate enterprise project cases into classroom teaching. Wang, Ping (2021) [20] described that formulation of artificial intelligence plays an important role of structural change in the development of vocational education in teaching thinking, teaching content, teaching mode, talent training and professional construction. Therefore, developing the vocational teacher’s ability, constructing development

mechanisms and updating the curriculum content is necessary in era of artificial intelligence. Hui, Feng (2020) [9] depicted that the emergence of artificial intelligence made employee requirement with strict quality and comprehensive. Hence vocational education colleges should understand the trends of artificial intelligence influences and the role on the development of education. Reform of vocational education as counter measure to cultivate high quality talents in line with the artificial intelligence development is crucial. According to Yang, Shuai, and Haicheng Bai (2020) [21], in the present industry 4.0 era, the production process has shown quick changes with excellent service because of the implementation of cyber-physical production systems. The author indicated that, in order for the vocational education to be more effective in supporting the development needs of industrial 4.0 it requires a frog leap in the curriculum development, learning, program management through a multi and trans-disciplinary across study program. Chen, Lijia, et al (2020) [25] assessed the impact of artificial intelligence on education using qualitative research approach and ascertained that artificial intelligence has extensively been adopted and used in education in different forms. The use of this platform has enabled teacher's effectiveness and efficiency resulting in improved instructional quality. It was also indicated that artificial intelligence provided students with improved learning experiences since it could enable the customization and personalization of learning materials to the needs and capabilities of students. Zeng, Desheng et al (2022) [24] claimed "industries have put new requirements and competence level of employee as result of high-quality development". Therefore, vocational education reform to cultivate complex technical and skilled labour force is required due to transformation of industry and inclusion of new technologies. In addition, reform in talent cultivation mode and evaluation mode realizing the connection between industries and education is important. Koricanac, Igor (2021) [12] posited that high level of competitiveness among automotive industries facilitated the implementation of AI in the system such as driverless features among many others resulting the demand for highly skilled personnel on the field. B. Ziblima and J. Nkrumahb (2018) [2] indicated that auto mechanic in Ghana lack the ability to use computer, manuals and modern equipment in their repair practice. Cars running in the street have become computerized and so do the repair job requirements which needs special talent training. The author claimed that "the current auto mechanic workers lack the ability to use diagnostic tools, computers, manuals and use internet which modern vehicles repair characteristics". Students' professional knowledge is affected by curriculum structure, curriculum process and curriculum content. This further affect labour force required by industries. Therefore, technical and vocational training shall understand industrial

needs and design teaching curriculum which incorporate the needs of industries Lu, Li-Shu et al (2013) [15].

Methodology

This work investigated the integration of artificial intelligence with automotive technology of higher vocational education in Ethiopia and qualitative analysis method has been employed. Qualitative analysis is chosen because people experience and quality of information is the main concern to gather necessary data in the context of the problem. Data has been collected using semi-structured interviews, literatures and observation. The interviewees were from employers, educational policy officers, teachers and directors, and students/graduates. Geleto, Lemecha (2018) [5] has taken samples from industry experts, employers, regional TVET authorities and teachers for TVET curriculum development study, which shows that sample selection for this work is fair. Interviewees for this work was from Bahir Dar city and Addis Ababa (capital city of Ethiopia). Audio record of total of 14 respondents have been transcribed from the aforementioned categories. Related literature reviews are collected and analysed for the purpose of researching the integration of existing vocational curriculum with artificial intelligence basics or content. Furthermore, literatures have been used to assess the curriculum reform methods, identify implementation factors, the challenges of vocational education in AI era, applications of AI in Automotive industry and to study the development of AI. Interview results are the main method of assessing the actual situation in implementation of basic skill and knowledge of AI in stakeholders such as enterprise, institutions and vocational education.

Sampling

The sample for this study is motivated by the possibility of indicating the right answers to the research questions from their numerous years of experience. The participants were contacted through face-to-face interview and virtual medias due to distance. For the purpose of anonymity participants only basic information such as type of job, experience, educational level and organization name have been collected.

Twenty open ended interview questions were prepared and delivered to a total of 14 individuals. Respondent were from different locations and from different stakeholders. Regarding sample size determination, Ken-Giami et al (2022) [11] referred that "theoretical saturation" is a point at which gathering more data reveals no new properties nor yields any further insight about the research questions.

Table: 1 Participants' profile

s.n	Representation	Occupation/position	Years of experience
1	Respondent 1	Garage owner and worker	2 and half
2	Respondent 2	Employee (mechanic in MENCO)	10
3	Respondent 3	Director (R. state VET curriculum development)	4
4	Respondent 4	Labor and skill ministry officer	13
5	Respondent 5	TVET director	17
6	Respondent 6	Auto. Dep. Director	20
7	Respondent 7	Employee (in field garage)	5
8	Respondent 8	Employee(mechanic)	25
9	Respondent 9	Employee (mechanic)	12
10	Respondent 10	Employer (Garage owner and worker)	3
11	Respondent 11	Employee (mechanic)	15
12	Respondent 12	Student (level-4 at Addis Ababa TVET)	Student (level 4)
13	Respondent 13	Teacher (lecturer at Bahir Dar TVET)	11
14	Respondent 14	Lecturer in Addis Ababa TVET	12

Interview

Semi-structured interview which is middling between structured and unstructured was used to collect qualitative data. According to Ken-Giami et al (2022) [11], semi-structured interview data collection method enables to follow a fixed set of questions and further probe beyond the questions. Therefore, this can give freedom to explore outside the prescribed questions that would result in unexpected data. The interview was conducted from December 2022 to March 2023 in Amharic (national language of Ethiopia). Each interview last between 10-56 minutes based on the number of questions and the respondents speed of speech. Before interview, interview questions was handed to the interviewees to help them prepare on the subject. All interviews began with a briefing about AI applications in vehicle technology and general purpose of the study.

Following these, interviewees were reminded about the confidentiality of the information they would provide for the sake of freedom in the entire process. They have been also reminded that there is no right or wrong answer as the end goal is not to judge what they have replied.

Transcribing

Each interview was conducted face-to face with the interviewee, and from employers, educational policy officers, teachers and directors, and students/graduates. They were from Bahir Dar city and Addis Ababa (capital city of Ethiopia). Audio record of total of respondents have been transcribed before the commencement of data analysis. The recording was in Amharic which has been transcribed English after importing in to MXQDA 2020 software.

Data analysis

Literatures and interview data was imported into MAXQDA 2020, which is one of the well-known qualitative data analysis software for sorting, keeping on track of data, coding and analysing data. Collected data put through different stages of coding and theme creation process. Hybrid type of coding system was used. Then themes were derived from set of codes which comply with the research questions. Therefore, the final conclusion of the study is drawn based on the analysis results of both the literature and interview results.

Conceptual frame work

Among many, the main factors which affect VET curriculum are teachers understanding, teaching methodology, policy, student prior knowledge and need of labour market. This study focused on curriculum content and artificial intelligence integration level with automotive technology graduate of vocational education on acquiring pertinent knowledge and skill required by the enterprises. In other words, the research work assesses the current integration of AI in the curriculum, identify content to be included to develop cognitive structure in integrated curricula of automotive technology(mechanic) major learning process.

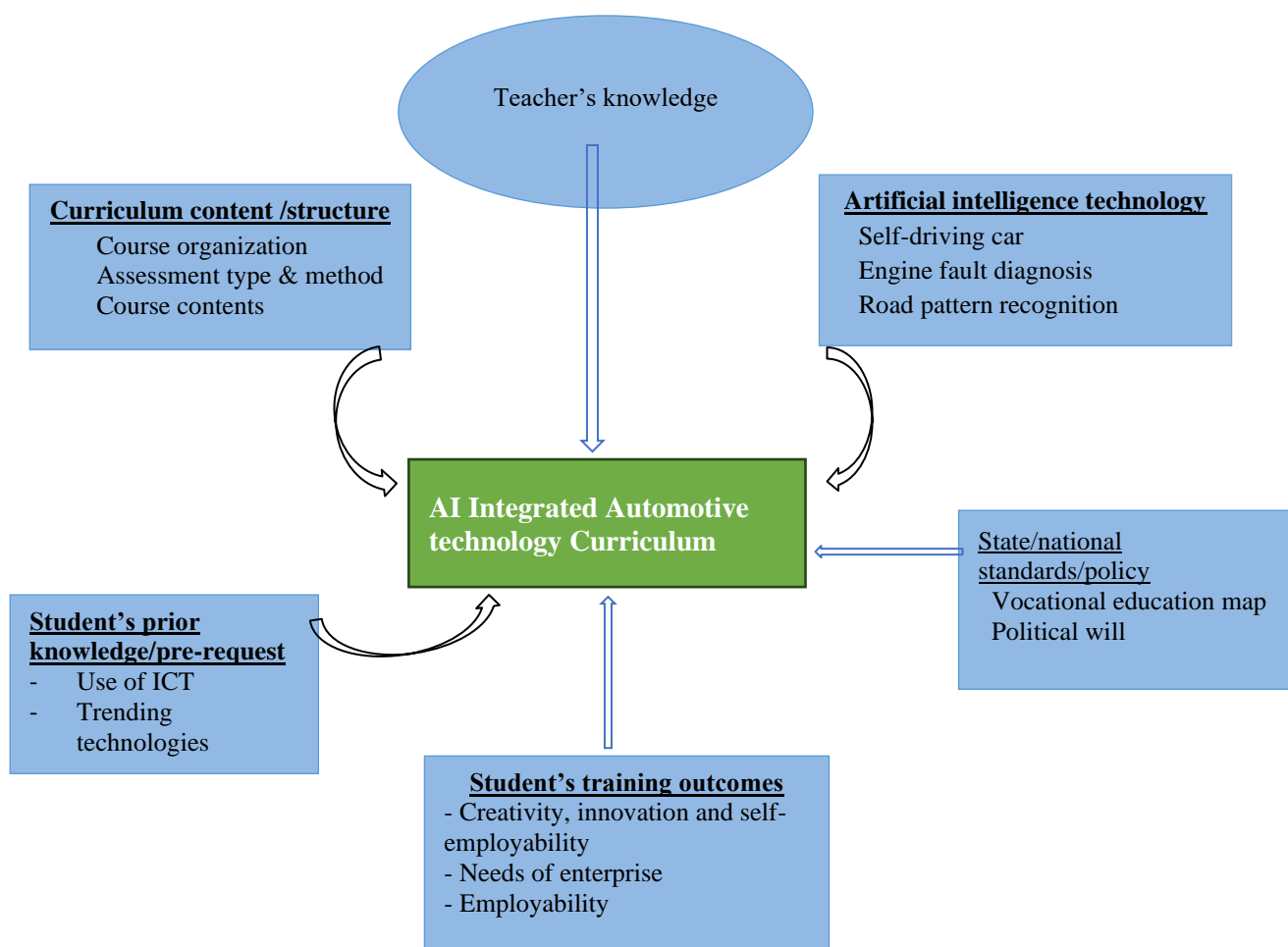


Fig. 1 integrated curriculum framework

Student prior knowledge

Students join vocational school with different prior knowledge, beliefs, attitudes and skills which influence how they are going to conceive and organize learned knowledge. This in turn affect how to apply, think, remember and create new knowledge because new knowledge and skill are dependent on pre-existing knowledge and skill. High

achievers are characterized in high general cognitive capabilities and prior knowledge or past academic achievement. They can also contribute more often on higher levels of conceptual learning. L. Boström (2013) [13] claimed that “there are many reasons for the need of previous knowledge for vocational education entrant”. The first reason is an increasingly complex reality comprising rapidly changing working environment that face students upon

enrolment, work process and to absorb advanced theoretical and practical knowledge during training. Dong, Anmei et al (2020) [4] shown that students with more prior knowledge and lower cognitive load are able to exercise higher levels of instrumental help-seeking and lead to good quality learning engagement.

Teacher's knowledge

In recent years, it is imperative to improve student learning outcomes which in turn improves the quality of the teaching workforce. In light of rapid changes in business and industry workplace technology, teachers have to be encouraged to update their knowledge constantly. These days, however, recruiting and retaining good quality teachers has become a challenge in some developing countries like Ethiopia. Assigning teachers to teach subjects for which they were not trained well affects the quality of teaching in negative way. In other words, teacher's quality is important factor in imparting gains in student achievement. In addition, pedagogical knowledge of teachers is another indicator of teacher quality. Therefore, teachers are expected to have good quality on content and pedagogical knowledge as well as learners' knowledge and characteristics. Ver loop, Nico et al (2001) [26] concluded that understanding of teacher knowledge would be useful to foster teacher education and to make educational innovations more successful.

Automotive curriculum integrated with artificial intelligence

Automotive curriculum is the dependent variable which is going to be influenced by the independent variables namely educational policy, student prior knowledge, teacher's knowledge, artificial intelligence technology application in automotive industry, curriculum structure and learning outcomes.

Educational policy

The foundation of technological advancement in any country lays in the effective implementation of educational policies. Educational policy generally refers to outlined ways of doing things which are usually linked to laws. There has been changes based on the directives from the federal government on vocational education curriculum intended to improve the qualities of graduates thereby to meet the requirements of the contemporary works. Ministry of Labor and Skill is most substantial body on the development and integration of vocational education and training teaching curriculum. Therefore, the government should emphasize technology-transfer through its educational policies.

Artificial intelligence technology application in automotive industry

In 21st century, life without manufacturing robots, marketing and stock trading bots, virtual travel agents, smart driver assistance, driverless cars and other innovations in different fields wouldn't have come into existence without development of AI. The role of AI in the automotive industry is huge. Self-driving and driver assistance in vehicle system are the prominent application of AI in automotive industry. Autonomous vehicles are currently deployed in cities and airports around the world. AI is also mainly used in pre-manufacturing, manufacturing process and production management of automobile. Artificial intelligence can carry out tasks which are normally performed by human with high accuracy.

Training outcomes

Curriculum is an integral parts of study outcomes, criteria of assessment of student achievements, content, methodologies, study environment, quality of teachers and students. The anticipated study outcomes are an essential element in the curriculum. Study outcomes depict whether the curriculum is related to the market needs and disclose the level of the cooperation between the schools and stakeholders. Moreover, the learned outcome of vocational education has to facilitate creativity, innovation and self-employability besides meeting industry needs.

Artificial Intelligence in Automotive Industry and Vocational Education and training of Ethiopia

The current VET system of Ethiopia

Ethiopian TVET has created national level coordinated training system. This decision has been made to share uniform resources and training anticipating good quality graduate that would assist the development of the nation. The other main aim of vocational training program other than developing workplace based human power is to increase the self-employed individuals who otherwise be jobless since they are high school dropout. This can also decrease the pressure on government due to joblessness. In general terms, the end goal of Ethiopian VET is to achieve measurable work-based skill pool and improve employment. However, training is not providing the desired goals much as result of inflexible curriculum which does not underpin the current labour market. Consequently, the objective and the innovative concept of automotive major competence is also questionable.

Vocational curriculum of automotive major has from level 1 up to level 4 (ministry of Labor and Skills, 2021). These levels have three types of occupational standard namely automotive mechanic, body repair and paint work and automotive electrical and electronics. These occupations have levels from 1-4 with different graduation outcomes and years of training. The teaching curriculum of the aforementioned occupations have been assessed whether they have AI related courses or not and the result has shown that there is no single course related to one of the disciplines of artificial intelligence. All the training courses in these curriculums are automotive major focus. In each level of qualification, the unit of competence/ courses are all limited to the fundamental/ conventional systems of automotive systems. The unit of competence at level three of automotive mechanic is supposed to deliver general knowledge of modern automotive systems as well. However, courses are in the level *Artificial intelligence application in automotive industry transformation*

The increasing sophistication of modern vehicle systems has exacerbated the complexity of product development, maintenance services, manufacturing and logistics process. Automotive industry is in major change due to the advancement of artificial intelligence. Artificial intelligence application can be found in all domain of automotive industry such as maintenance, sales, manufacturing, vehicle design, autonomous vehicle, vehicle safety and marketing. These days, most of vehicles produced have up to 50 electronic control unit modules and have multiple sensors which can analyse real-time situation and decision making. There is a major shift from hardware to software-based process in manufacturing vehicles and driving systems. Gusikhin, Oleg et al (2007) [6] have overviewed usage of AI in automotive industries and indicated that AI is being applied in manufacturing, onboard diagnosis system, warranty analysis and vehicle design. Some of AI in-vehicle systems are neural-network based virtual sensors, fuzzy neural system control, speech recognition, on-board diagnosis system and intelligent safety systems. Li, Jun et al (2018) [14] described vehicle produced these days consists of artificial technologies such as path planning, vehicle communication, driverless car, detect pedestrian, lane change, map building, driver assistance and environmental perception functions. The need of using intelligent vehicle will always increase as the rapid increment of car ownership rise. Ordinary car manufacturers are changing to smart and connected production processes. Yuanfeng, Lv et al (2021) [22] described that, in recent years, Result and Discussion

Artificial intelligence in automotive industry application is one of the revolutionary technological innovations in the current era. AI has tremendous applications in education,

of conventional systems and laboratory equipment are also traditional that are equipped with conventional systems which are being substituted with modern systems as modern vehicles take the role. In addition, there is no ICT or language courses which can help learners achieve real world of work after graduation. For instance, learners would not do accident analysis without sufficient knowledge and skill of computer science but there are unit of competence like performing accident analysis and project cost analysis at level five as occupational standard. Analysing works do require some sort of computer knowledge. Moreover, there is no courses which is intended/introduce recent technologies in the field of automotive. Therefore, AI in Ethiopian vocational education is not yet implemented or will not be implemented in the near future even though AI fitted vehicles are being serviced in local garages.

automotive engineering has made unprecedented progress in use of artificial intelligence technology in automobile manufacturing and safety. B. Ziblima and J. Nkrumahb (2018) [2] described that computers are now component parts of steering, brake system and many other components of automobile. These days, automotive systems incorporate new technologies and have become standards. Auto mechanic graduates confront challenges at workplace as their training was not in-line with the technological know-how that are required by the industry. Repairing and fixing vehicle job has become computer-based.

Artificial intelligence can perform tasks as human being. The advancement of computer science technologies results incredible changes to industries across the world. Companies make great effort to innovation so as to sustain their standings in the global market. Autonomous lane change, shared autonomous vehicles, vehicle guide and autonomous public transport is already in use.

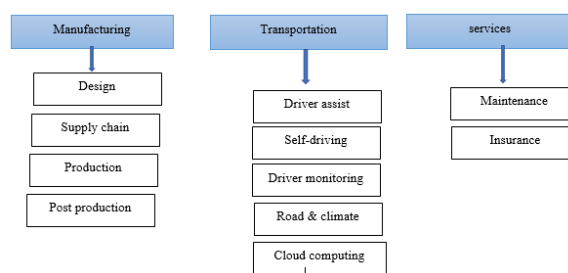


Figure 2 application of AI in automotive industry (A. Koptelov 2022) [1]

governance, medical and retail industries.

Twenty open ended interview questions were prepared and delivered to a total of 14 individuals. Respondent were from different locations and from different

stakeholders. Audio of respondents were recorded carefully for later transcription purpose which spans from 10 up to 56 minutes. Among the interviewees, about 50% of them were students and employees intended to collect the actual data that are pertinent to answer the research questions. All of the employees interviewed were VET/TVET graduates, three of them have their own garage. Those employees work experience range from two half up to 25 years. Teachers, directors of vocational educations, labour and skill, and technical education ministry interviewees were all master degree holder. Teachers have more than 10 years of experience in teaching while directors and officers have the minimum of two years and 20 years maximum working experience. Respondents were all males across the four categories of interviewees because automotive technology is deemed to be for men as it requires physical strength. There might be few female automotive technicians however searching them would take more time as a result there was no female respondents in the interview. The interviewees were from Bahir Dar city (Regional state of Amhara) and Addis Ababa city (a capital city of Ethiopia). This has helped to collect nation-wide experiences in the field.

The result of this research shows the results from two categories of data which are literature review and

interview. The comparison results from these two data sets have been stated. The first section of the result discusses about the interview results which has been collected from four different stakeholders namely employers, education officials, graduates/workers and teaching staffs. Based on the research question and interview result themes has been developed these are:

- Assessment of artificial intelligence integration in automotive technology curriculum and future trends in the field
- Courses required to narrow the gap between vocational school and the industry requirements

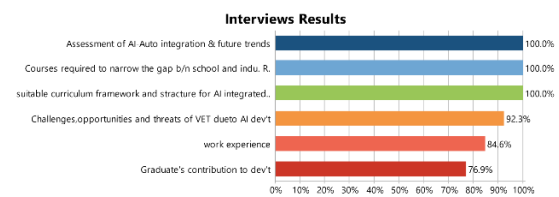


Fig. 3 percentage of coded documents (sub-code statistics)

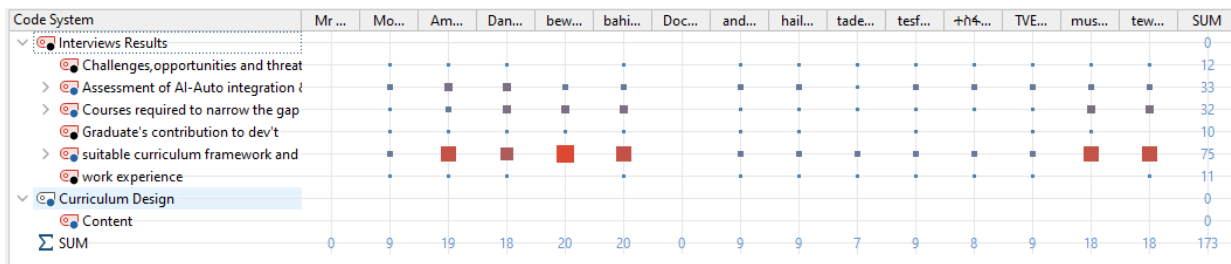


Fig. 4 code distribution and number of coded segments

The integration level of automotive technology curriculum of VET in Ethiopia and AI application on vehicles

Artificial intelligence application in automotive industries tremendously advances which has become great challenge to the vocational school and its graduates. The knowledge and skill level in school training is outdated that results clear skill gap with the industries required quality graduate. This gap can be filled by integrating some basic AI course contents into teaching curriculum related to vehicle system applications. The assessment of integration level in Ethiopian vocational education and training curriculum has been done by interviewing whether there is integration or not at this moment. And 36% the respondent replied as there is very less integration where as 50% of the respondents replied no integration at all.

There is less integration, but there are few courses at name level. what is required is supporting those courses with laboratory works and detailed theories teaching. It should not be in names only, there has to be intensive practice on modern systems (respondent 1).

No, there is no integration. What is better now is to watch TV shows that broadcast about automotive system diagnosis; the best example is Ethio-automotive TV show (respondent 11).

One teacher among the interviewees claimed that there is noticeable knowledge gap even on basic courses on the teachers who train to be TVET teachers. He stressed 'knowledge gap on teachers means knowledge gap on students obviously'.

To reduce the mis-match between school training and work-place tasks, the integration of these two shall be strengthened in the future. In this regard, many of the respondent claimed that integration is important without hesitation no matter what resources the school, enterprise and the nation have. This integration has to begin now at this moment, to have a start is always difficult, they added. Service companies like field garages are working with experiences which is attained through trial and error so VET graduates with integrated curriculum can be the opportunity to empower garages with the right personnel. On the other hand, three respondents (4, 5 and 12) on the director level and student posited integration at this moment in our country is unthinkable and probably not necessary as we have a lot to do on normal education policy first.

“Since there is lack of teachers’ capacity building, student competence, shortage of required infrastructure, trainer vs technology gap and between student and the technology gap, there would be huge challenge, I think. Perhaps, it might not be possible” (respondent 12).

Most of the learners learn at work place than school. The curriculum designed by the industry satisfy industry requirement. Developing ways to teach the required skills in school is also the main option to satisfies the industry. New technologies and customer preferences are demanding automotive technology teaching curriculum to be reconstructed.

Selected courses to bridge existing Automotive technology training to AI inclusive learning

The advancement of artificial intelligence has brought a major shift in automotive industry. Artificial intelligence is being used in transportation, vehicle maintenance service, manufacturing and sales which results efficient, smart and safer process for the sector. Driving these days on the way to shift from human driver to self-driving car and there is an imperative shift from hardware-based operation to software in the vehicle systems. This technological advancement in vehicle systems require highly skill man-power on the field. Vocational education and training is the source of these workers/ technicians/ who supposed to meet the requirements of the current technology advancement in the sector. Artificial intelligence consists of many different disciplines which makes difficult for the education to adapt. However, the school need to make relevant changes to keep the pace with the technology advancement thereby the graduate recruitment by the employers increases.

In this research, interviewees from different background have been asked about the disciplines and course content of AI in vehicle systems to answer the demand of new knowledge and skill of auto-technician as well as to measure the popularity of AI in the country. Teachers, directors and officials were asked about disciplines that AI accompanied since they have better understanding and knowledge on the subject than other respondents who probably forget to mention different disciplines and their connection. On this subject, respondent 3 is a regional state vocational enterprise officer who is responsible in curriculum design and review of vocational education and training responded as he does not know the details, however, he is the one who is responsible to clearly know the composition and relationships of each discipline better than others irrespective of his position. Interviewee 5, 13 and 14, mechanical engineering, software engineering, electrical engineering and computer science are the disciplines from which AI is composed of. The combination of aforementioned major engineering science knowledge is in application to produce all intelligent devices or machines. Interviewee 4 described; AI do take all engineering concept plus language that helps to mimic human brain thoughts. On the other hand, respondent 6 replied that mathematics, physics and computer are the core subjects for AI to be functional.

“Mechanical engineering, electrical engineering, electronic system and computer programming” (interviewee 14).

Furthermore, almost all respondents described that adaptation of artificial intelligence technologies can be facilitated by regularly adding new technologies related to vehicle systems. Getting to know new technologies increases the chance of catching AI content and makes it easier while facing the actual problem in work-place. Respondent 4 claimed that regular renewing time for the curriculum is 10 years for vocational education which would be a long wait because vocational trainings are market oriented.

“Ethiopian TVET curriculum is made to be flexible. A teacher or trainer has the right to add or remove course contents if they believe to do so. So, if this trend grows it would be possible to add or substitute contents with new one that can facilitate AI learning” (interviewee 14).

One of the research questions is identifying the courses to be added in the newly designed curriculum which can meet the needs of the automotive industry. Therefore, all

of the interviewees have been asked and they have suggested different courses based on their experiences.

“There are courses which would have been included such as English which will help to develop writing, speaking and communicating skills. The other fundamental course is mathematics which needs to be incorporated. The previous program named as Advanced automotive technician in which technical drawing, fluid mechanics and machine drawing are part of the program to mention some. But these courses are not available in these day’s curriculum. You can imagine what will happen if an automotive technician cannot understand/ read drawing properly. What if he/she join

manufacturing company? yeah it will be a complete loss. furthermore, mechatronics is also important course for technicians to learn” (respondent 5).

To improve the modernization of vocational education and training curriculum courses and contents such as information technology, English, computer programming, electric and electronics, mechanical engineering, automotive related software, basic AI in vehicle application, electronic fuel injection system, electric vehicle, sensor, actuator, animation and simulator training as suggested by the respondents. The table below shows the response of each interviewee.

Table 3 suggested courses to facilitate AI integration and meet automotive industry requirement

Respondent	Status (position)	Recommended Course
Respondent 5	TVET director	English, mathematics, technical drawing, fluid mechanics and mechatronics
Respondent 6	Auto. Dep. director	Basic AI, Information Technology and English
Respondent 7	Employee (in field garage)	Electronic fuel injection (EFI), computer, English and Electric vehicle
Respondent 8	Employee(mechanic)	Automotive electric and electronics
Respondent 9	Employee (mechanic)	Electric system, computer, automobile painting
Respondent 10	Employer (Garage owner and worker)	It is difficult to mention one, I suggest teachers, experts and competency examiners can discuss and decide on the course types and contents.
Respondent 11	Employee (mechanic)	Fuel injection system, almost all vehicles have this system. literally this system is not available as course in school.
Respondent 12	Student (level-4 at Addis ababa TVET)	Course of AI in connection with on vehicle application and also electric vehicle systems. Most of the existing courses are not important so the current relevant technologies must be added. from mechanical, computer. electrical...etc
Respondent 13	Teacher (trainer at Addis Ababa TVET)	Literally, whatsoever the technology is, it is not out of the basic electricity and basic electronics science. therefore, the course shall incorporate these details including the facilities. In addition, English and Mathematics are compulsory
Respondent 1	Garage owner and worker	AI focused basic courses and sensor and actuator

Some of the respondents have proposed basic courses of artificial intelligence to be added in the newly designed integrated automotive curriculum so that AI development in automotive industry can be taught in vocational education and training school. Consequently, the trainee can grab relevant skills and knowledge to serve in maintenance, manufacturing, sales and transportation system

sectors thereby unemployment reduces and national development increases. On the other hand, respondents who did not specify some sort of course indicates that they have knowledge gap on the modern automotive systems and AI applications. With this regard, selected experts shall discuss and decide the curriculum content by taking other country’s experiences and cooperative training with foreign companies.

Automobile companies incorporate different types of technologies in the vehicle system, categorizing and selecting the common (universal) technology needs an expert. To keep the pace with the technology advancement reviewing and renewing VET curriculum in short time interval is critical factor.

Choosing and integrating new content to accompany AI in the training curriculum is not simple task as mentioned by the interviewees. However, starting from what is known already to our capacity is satisfactory for the time being. Integration of anticipated contents of selected technologies can be added to laboratory classes with the existing laboratory exercises. For this to happen, more laboratory classes hours and longer industrial practice must be maintained.

“Though the knowledge gap exists on AI, we can include what is known already such as basic AI courses, EFI engine, safety system, engine control management and drive train. So electric and electronics of the engine needs to be addressed first as these will be the way to AI” (respondent 13).

Conclusion

The rapid development of AI application has changed the conventional work process in many fields such as automotive engineering, electrical engineering, medical science, production process and education systems. The increased use of AI in world of work has affected vocational education and training graduate incredibly hard. Automotive mechanic program in VET is one of the disciplines which faced the major challenge from AI applications. These days, most of the vehicle produced are equipped with some sort of intelligence in its systems for different purposes such as emergency braking, navigation, lane change detection, engine diagnosis tools and autonomous vehicles which require comprehensive skill and knowledge during maintenance services. This study investigated the existing integration of AI into automotive mechanic training courses and make AI course selection which going to be incorporated in the training as a result AI in vehicle system application can be taught at school. Qualitative research design was used to analyse the interview results and literatures related to vocational education and training, and AI application in industries that increase the quality requirement of VET graduates. Interviewees was from educational policy officers, employers, teachers and directors, and students/graduates. The analysis was supported with MAXQDA 2020 software.

The assessment result on the integration level of AI content in automotive technology training of vocational education and training in Ethiopia was found as weak, that

50% of the respondent replied as there is no integration at all and 36% responded less integration. Besides, teachers lack basic knowledge on basic courses which results huge knowledge gap on students. To mitigate the skill and knowledge mis-match between school training and workplace, the integration of AI has to be started without hesitation no matter what resources the school have at this moment.

Artificial intelligence consists of many different disciplines which makes difficult for the education to adapt. However, VET schools need to incorporate courses from software engineering, computer science, mathematics, electrical engineering and mechanical engineering which are the fundamental engineering science to innovate and understand AI technology in vehicle systems. Regularly removing and adding new vehicle technologies to the curriculum would facilitate the learning and familiarization of AI technologies. Furthermore, interviewees suggested courses like information technology, English, computer programming, electric and electronics, automotive related software, basic AI in vehicle application, electronic fuel injection system, electric vehicle, sensor, actuator, animation and simulator training can improve competence of graduates.

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