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DEVELOPING AN AI INTEGRATION FRAMEWORK IN TVET
CURRICULUM: THE CASE OF AATPC

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April, 2026

Addis Ababa, Ethiopia

Federal Technical and Vocational Training Institute

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**Developing an AI Integration Framework in TVET
Curriculum: The Case of AATPC**

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A Thesis Submitted to the Federal Technical and Vocational Training Institute, School of Graduate Studies, Faculty of Electrical, Electronics and Information and Communication Technology, in Partial Fulfillment of the Requirements for the award of the Degree of Masters of Sciences in Information and Communication Technology.

April, 2026

Addis Ababa, Ethiopia

DECLARATION

I, Zerihun Basazin, the undersigned, declare that this thesis entitled: **“Developing an AI Integration Framework in TVET Curriculum: The Case of AATPC”** is my original work. I have undertaken the research work independently with the guidance and support of the research advisor. This study has not been submitted for any degree or diploma program in this or any other institutions and that all sources of material used for the thesis have been duly acknowledged.

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CERTIFICATION

This is to attest that the thesis presented by Zerihun Basazin, "**Developing an AI Integration Framework in TVET Curriculum: The Case of AATPC**" and submitted in partial fulfillment of the requirements for the Master's degree in MSC in Information and Communication Technology complies with the regulations of the university and meets the accepted standards of originality and quality

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Table of Contents

DECLARATION	i
CERTIFICATION	ii
ACKNOWLEDGEMENT	iii
List of Figures	viii
List of Tables	ix
List of Abbreviations	x
ABSTRACT.....	xi
CHAPTER ONE	1
INTRODUCTION	1
1.1. Background of the Study	1
1.2. Motivation of the Study	3
1.3. Statement of the Problems	5
1.4. Objectives of the Study	5
1.4.1. General Objectives.....	6
1.4.2. Specific Objectives	6
1.5. Research Questions	6
1.6. Scope/Delimitation of the Study	6
1.7. Significance of the Study	7
1.8. Organization of the Study	8
CHAPTER TWO	9
LITERATURE REVIEW AND RELATED WORKS	9
2.1. Introduction.....	9
2.2. AI Integration in TVET	10
2.1.1. Theoretical Foundation	10
2.1.2. Constructivist Learning Theory	11
2.1.3. Technological Pedagogical Content Knowledge (TPACK).....	11
2.1.4. Socio Technical System Theory	11
2.1.5. AI in Education and its Importance to TVET	12
2.1.6. Curriculum Reform and Framework Development	15
2.1.7. Challenges of Implementing AI in Developing Countries.....	15

2.3.	Review of Literature Review	16
2.4.	Summary	19
2.5.	Research Gap	20
CHAPTER THREE		22
RESEARCH METHODOLOGY		22
3.1.	Introduction.....	22
3.1.1.	Research Approach	23
3.1.2.	Data Collection Methods	25
3.1.3.	Primary Data	26
3.1.4.	Secondary Data	27
3.1.5.	Research Population and Sample Size	28
3.1.6.	Data Analysis Techniques.....	29
3.1.7.	Sampling and Data Collection Procedures.....	29
3.1.8.	Sample Size and Participants	30
3.1.9.	Inclusion Criteria	30
3.1.10.	Methods of Data Analysis.....	30
3.2.	Design and Development.....	32
3.3.	Demonstration.....	32
3.4.	Research Design.....	32
3.5.	Evaluation	33
3.6.	Communication.....	34
3.7.	Ethical Consideration.....	34
CHAPTER FOUR.....		35
DATA ANALYSIS AND DISCUSSION.....		35
4.1.	Introduction.....	35
4.2.	Response Rate.....	35
4.3.	General Information.....	35
4.1.1.	Respondents' Gender	35
4.1.2.	Respondents' Educational level.....	36
4.1.3.	Job Category of the Respondent	36
4.4.	Qualitative Data Analysis and Interpretation.....	62

4.4.1.	Thematic Analysis	62
4.4.2.	Coding Process.....	62
4.4.3.	Code Frequency Analysis	62
4.5.	Themes Interpretation	63
4.5.1.	Training Gap	63
4.5.2.	Institutional Barriers	63
4.5.3.	Positive Impact.....	63
4.5.4.	AI Usage	64
4.5.5.	Future Needs	64
4.5.6.	Psychological Barriers	64
4.5.7.	Infrastructure Issues	64
4.5.8.	AI Awareness.....	65
4.6.	Components of the Proposed Framework.....	66
4.7.	The Proposed Framework	70
4.8.	Institutional Readiness	72
4.9.	Human Capacity (Teachers & Staff Readiness).....	73
4.10.	Curriculum and Pedagogical Integration	75
4.11.	Technological Infrastructure	76
4.12.	Data Management and Governance	77
4.13.	Sustainability and Scalability.....	78
4.14.	Ethical, Legal & Policy Framework	79
4.15.	Stakeholder Engagement.....	80
4.16.	Integration of Constructivist Learning Theory, TPACK and STS into the Framework	81
4.17.	Chapter Summary	82
CHAPTER FIVE		84
FRAMEWORK EVALUATION, VALIDATION AND IMPLEMENTATION READINESS.....		84
5.1.	Introduction.....	84
5.2.	Evaluation of the Framework.....	84
CHAPTER SIX.....		92
CONCLUSION AND RECOMMENDATION.....		92
6.1.	Introduction.....	92

6.2. Conclusion	92
6.2a. Achievement of the Specific Objectives	93
6.2b. Answers to the Research Questions	94
6.3. Novelty and Contributions of the Study	95
6.4. Recommendations.....	96
6.5. Limitations of the Study.....	97
6.6. Future Works	98
Reference	99
Appendix.....	107
Appendix I	109
Appendix II.....	110
Appendix III.....	112
Appendix IV	113
Appendix V.....	117

List of Figures

Figure 2.1: Multidimensional influence or impact of AI in education.....	14
Figure 3.1: Design Science Research Methodology Process Models (Peppers et al., 2006) ..	23
Figure 3.2: Interview process of the research to reach multiple sources	26
Figure 4.1: Qualitative Thematic Analysis Workflow	65
Figure 4.2: Thematic Analysis of AI Integration in AATPC	66
Figure 4.3: AI Integration Framework for TVET Curriculum: The case of AATPC	70
Figure 5.1: Evaluation Result for Framework Utility and Applicability	89
Figure 5.2: Evaluation Result for the Content of the framework	90

List of Tables

Table 2.1: Related Works.....	17
Table 3.1: Target Population.....	29
Table 3.2: Cronbach’s alpha results from the pilot test (Source reliability test 2020).....	31
Table 4.1: Gender of Respondents	35
Table 4.2: Respondents’ Educational level	36
Table 4.3: Job Category of the Respondent	36
Table 4.4: Frequency Analysis of Personal Awareness & Skills (Human capacity)	37
Table 4.5: Frequency Analysis of Stakeholder Engagement	40
Table 4.6: Frequency Analysis AI Institutional Readiness	42
Table 4.7: Frequency Analysis of Data Governance & Ethical standard.....	45
Table 4.8: Frequency Analysis of Demographic Features for AI Integration Study	49
Table 4.9: Frequency Analysis for Technological Infrastructure.....	51
Table 4.10: Frequency Analysis of Curriculum and Pedagogical Integration	53
Table 4.11: Frequency Analysis of Sustainability and scalability	56
Table 4.12: Technical Challenges in AI Integration Framework (Open-response question).....	58
Table 4.13: Strategic and Implementations on AI Integration Framework.....	59
Table 4.14: Data-Driven Emergence of AI Integration Framework Components for AATPC.....	67
Table 6.1: Achievement of the Specific Objectives	93

List of Abbreviations

AI	Artificial Intelligence
CK	Content Knowledge
PK	Pedagogical Knowledge
TK	Technological Knowledge
ICT	Information and Communication Technology
STS	Socio-Technical Systems
TVET	Technical and Vocational Educational Training
UNESCO	United Nations Educational, Scientific and Cultural Organization
TPACK	Technological Pedagogical Content Knowledge
IR	Industrial Revolution
AATPC	Addis Ababa Tegnabareid Polytechnic College
ISO	International Organization for Standardization
MoIT	Ministry of Innovation and Technology
SPSS	Statistical Package for the Social Sciences
FTVETI	Federal Technical and Vocational Educational and Training Institute
MOLS	Minister of Labour and Skills
ML	Machine Learning
NLP	Natural Language Processing
AR	Augmented Reality
DSR	Design Science Research
FMC	Framework Component
AIIF	AI Integration Framework
AUDES	African Union Digital Education Strategy
GIZ	German Agency for International Cooperation
UN	United Nations

ABSTRACT

AI is increasingly transforming the education sector by enhancing personalized learning, automating, administrative task in teaching and learning process. However, the use of AI in TVET in Ethiopia is still in its initial stage with low infrastructure, low digital literacy among teachers and lack of a structured implementation strategy. This research attempts to fill these gaps by developing a contextualized framework for integration of AI into TVET curriculum using the case study of AATPC. The research use a mixed-methods research design. Focus groups and interviews were used to gather data from TVET instructors, administrators, curriculum developer. We also collected using questionnaire from students and instructors. Thematic analysis and descriptive statistics were used to analyze the data. The data was analyzed using thematic analysis and descriptive statistics. A total of 72 questionnaires were distributed. Out of these 69 were returned while 3 were not returned. Among the returned questionnaires 2 were excluded due to incomplete or invalid responses. Therefore, 67 valid questionnaires (93%) were considered valid for analysis. Validity and reliability tests were conducted to assess coverage of the topic, with a Cronbach's alpha coefficient of 0.988. In addition, observation and document review were conducted to support respondents' views. The collected data were processed using Python programing and IBM SPSS Version 27.0 statistical software. The outcomes of the study indicated that apart from the fact that AATPC has shown a great institutional commitment and positive perceptions towards the adoption of AI. However, there are still many problems like lack of formal training and low level of faculty awareness and also there is no AI course in the curriculum. In addition, limited stakeholder collaboration and lack of sufficient policy support have been identified as the main factors hindering the AI integration process. In line with these findings, the research designed a detailed AI integration framework for AATPC that included the strategic framework of the curriculum, faculty capacity building, infrastructure enhancement, policy guidance and monitoring mechanisms. The framework will help Ethiopian TVET institutions to overcome existing challenges to adopt AI in the TVET education system and equip the graduates with AI related skills for the rapidly changing digital and industrial economies.

Keywords: Artificial Intelligence, TVET, Curriculum Integration, Digital Readiness, AI in Education, Industry 4.0.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

AI refers to the Imitation of human intellectual skills by computers and machines, allowing them to carry out functions like learning, logical thinking, solving problems and comprehending natural language[1][2]. AI in education is gradual changing the delivery, access and administration of knowledge. It enhances learning experiences through intelligent systems that learn and align with the need of different learners and streamlines time consuming processes for instructors. The role of AI in education are the fields in which these technologies are utilized to improve learning outcomes. Among some of these uses are intelligent tutoring systems that provide personalized training, personalize learning systems that align content tailored to a learner's performance and natural language processing systems that provide automated scoring and live language assistance. In addition, Teachers can monitor student progress, spot learning gaps and make data-driven decisions with the help of learning analytics and data mining. [3]. AI is also used in assessments to offer instant feedback and mark student assignments successfully. Virtual assistants and chatbots can also help students by providing support around clock and robotics and simulations provide learners with interactively and experimental learning experiences. Another critical area in ethics where the use of AI in education can be fair, transparent and respectful of data privacy. Together, these areas will help to personalize make education inclusive and meet the need of the digital age [4][5].

Additionally, AI has emerged as a force that is transforming our way of life and work. AI is a system or device that enables human intelligence to learn, reason, problem-solve and make judgments normally handled by humans[6]. AI is already changing the way education is done. It now controls grading, adaptive learning and intelligent tutors. AI is used to automate and prevent maintenance processes in manufacturing [7], [8]. It is being applied in agriculture to monitor and increase crop yields and in health care to help doctors diagnose their patients accurately and prescribe new drugs. AI is already being implemented in vocational education programs in

countries such as China, South Korea and Germany to prepare students for the needs of modern workplaces[9][10][11]. It is now a challenge and an opportunity for Ethiopia to respond to this technology while also using AI to ensure graduates of the TVET program are ready to compete and succeed in a fast changing world economy.

In Ethiopia, TVET colleges are critical avenues for developing capacity in the skilled labor needed by various sectors [12]. TVET colleges can close the gap between workshop and work with competency-based teaching, industry-specific training, practical learning, workplace assignments, applied research and technology transfer that align theories with production and service settings. Yet despite their important role, Ethiopian TVET colleges are severely hindered from keeping pace with developments in technology on the global front[13]. Innovative pedagogical methods, outdated curricula and insufficient exposure to digital tools undermine the capability of such institutions to produce competitive graduates to the modern day job market[14]. Absence of AI related content and skills in TVET curricula further compounds the situation with a gap in graduates' skills and employers' expectations[15].

One such institution is AATPC one of the oldest and most prominent TVETs in the country. AATPC began life in 1942 as the country's first pioneer technical school, with an aim to train technicians and technical supervisors to help develop the nation in areas such as manufacturing, telecommunications, electricity and agriculture. Over the years the institution has evolved to offer a wide range of training in different fields such as ICT, electrical and electronics, automotive, construction technology, manufacturing, business, among many others. The institution currently offers competency-based TVET programs (level I-V) focusing on hands-on training. The institution has played a huge role in establishing the workforce of Ethiopia with some of the key industries and agencies handling some of the key sectors in the country including Ethiopian Airlines, electricity agencies and industries. It has played a critical part in international development by having strategic partnerships with organizations such as GIZ and UN funded initiatives to increase digitization, entrepreneurship and innovation. AATPC supports research that bridges the gap that often exists between education and industry. The institution has also underwent a new technology-based perspective.

Globally, various nations have begun integrating AI into vocational training systems to ensure that students are sufficiently equipped for the future workplace. For instance, Germany, South Korea and China have moved ahead and implementing policies and frameworks that include AI in teaching, learning and organizational processes in TVET system. These countries provide valuable examples of how to apply AI for vocational training and education. But, they do not seem to be able to replicate these models in Ethiopia due to differences in infrastructure, policy and institutional readiness[16]. In light of these challenges and opportunities it is critical to develop a tailored to the context approach to integrating AI into the TVET curriculum in Ethiopia especially in AATPC. This approach should address issues of technology and society that may require a socio-technical intervention to make integration of AI possible, sustainable and educationally appropriate. Thus, my research aims to fill this gap by developing a contextualized framework for the integration of AI, based on international best practices but suited to Ethiopian realities[17].

1.2. Motivation of the Study

The motivation for conducting this research is the increasing importance of AI in influencing the upcoming of work, learning and economic growth in the world [15]. Industries are transformed by AI constantly which calls for education systems especially TVET to change the respond. AATPC has a responsibility to produce skilled and competent workers to meet local and international market demands. The curriculum of TVET does not match rapidly changing technologies. Skills, tools and concepts related to AI are not included in most of the programs leaving the students ready for future employment opportunities requiring knowledge in digital and intelligent technology[15]. This study also aims to connect TVET education with Ethiopia's national development plan including its digital economy strategy and vision of industrialization. Without integrating technology like AI into vocational training Ethiopia risks leaving behind its human resources to take advantage of and contribute to the IR 4.0. Watching other countries implement AI into their workplaces has highlighted the potential benefits that could come to Ethiopia. Yet such international observations also underscore the wisdom of mapping out a local strategy that considers Ethiopia's particular socio-economic context, institutional progress and policy environment[18].

AATPC is located in Addis Ababa and is one of the largest and oldest TVET institutions in Ethiopia. The college is under the Federal TVET Institute and offers competency-based training in different technical areas such as ICT, Garment & Textile, Electrical & Electronics technology, Automotive Technology, Manufacturing and other industrial fields. AATPC has over the years, become a major heart for the production of middle-level technical professionals who are the main drivers of Ethiopia's industrialization and workforce development goals. The institute is providing education to thousands of students every year through Level 3, Level 4 diploma and short-term vocational training programs. It is working with the industry sectors to make the hands-on training more relevant to the labor market demands, but such cooperation is still minimal and mostly informal. Being a public TVET institution, AATPC is also responsible for the implementation of national TVET reform programs such as the digital transformation and the use of emerging technologies. Most of the curricula in departments are still basically traditional and do not yet incorporate modern competencies like AI, data science, automation or Industry 4.0 skills. As Ethiopia is gearing toward a digital economy, these discrepancies are putting a lot of pressure on institutions such as AATPC to update the teaching, learning and curriculum delivery methods they use. In the light of AATPC's impact on the preparation of the Ethiopian workforce and the possibility of its being a model for other TVET institutions the integration of AI into its curriculum is not only a timely intervention but also great national importance. Therefore, this study uses AATPC as a case study institution to determine how AI can be embedded in TVET programs in Ethiopia from a contextual, technical and pedagogical perspective.

Besides, there is excited personal and academic interest in learning about how education can ensure equitable access, innovative and responsive toward the future. AI introduces new forms of teaching and learning via adaptive learning technology, intelligent tutoring and evidence based instruction which can significantly improve the quality and expand the reach of TVET training in AATPC. The lack of a strategic framework to guide the integration is both an opportunity and a challenge. We are motivated by the belief that a well-designed contextual AI integration framework can transform the field for more efficient, effective and applicability of TVET fulfilling national goals and empowering Ethiopian youth with competencies to satisfy the future[9][19][20].

1.3. Statement of the Problems

TVET plays a significant contribution in equipping Ethiopia's growing number of youths with practical skills to enable them to join the labor market and contribute to national economic growth [21]. Despite the extensive and growing application of AI technologies in most sectors around the world. AATPC TVET curriculum remains primarily traditional with little or no integration of AI related knowledge and skills. This gap has made TVET graduates insufficiently prepared to meet the demands of the modern workplace where digital literacy and nimbleness will be increasingly important [15]. Researchers will welcome the potential of AI transforming education by improving instructional delivery mapping curricula to industry needs and preparing students for employment. Some previous studies have piloted programs or modules of AI in TVET curricula. However, most of the earlier research has following limitations. Most of the previous studies are set in well equipped, policy intensive and high income country contexts and will not account for the unique policy, financial and capacity related constraints developing country contexts particularly in AATPC face. Furthermore, much of the previous literature focuses on adding standalone modules or training sessions in AI but not on a contextualized based framework that can guide policy makers, educators and stakeholders regarding the successful incorporate AI into TVET educational program in a sustainable, coherent and realistic manner[20]. This gap a contextualized framework for incorporating AI into TVET curriculum in AATPC a major limitation in previous research. Without this framework policy makers, educators and stakeholder lacked clear guidance for developing curricula and training programs that address industry needs, policy makers and the country's developmental priorities. In response to these limitations, this study developed a context-specific, structured AI integration framework for AATPC. The framework supports policymakers, educators, and training institutions in collaboratively incorporating AI into TVET curricula, thereby enhancing graduate employability and strengthening their contribution to the country's digital transformation.

1.4. Objectives of the Study

The objectives of this research were separated into specific and general objective. These were then described in detail.

1.4.1. General Objectives

The general objective of the study is to develop framework for integrating AI into TVET curriculum in order to make vocational training relevant to the labour market.

1.4.2. Specific Objectives

1. To assess the current practice of AI integration and the level of AI awareness in the curriculum at AATPC.
2. To evaluate the institutional readiness of AATPC for integrating AI into its curriculum.
3. To identify the key challenges affecting the implementation of AI in the TVET curriculum at AATPC.
4. To develop a contextualized framework for effective integration of AI into TVET curriculum at AATPC curriculum.

1.5. Research Questions

1. What are the current practices of AI integration and the level of AI awareness in the TVET curriculum at AATPC?
2. What is the level of institutional readiness of AATPC for integrating AI into its curriculum?
3. What are the key challenges affecting the implementation of AI in the TVET curriculum at AATPC?
4. How can a contextualized framework be developed for effective integration of AI into the TVET curriculum at AATPC?

1.6. Scope/Delimitation of the Study

The research is mainly interested in developing a framework for the integration of AI into TVET curricula related to AATPC. The study focuses on selected public TVET centers AATPC, policymakers, instructors, curriculum developers, administrators/staff and stakeholders in the curriculum design and implementation. It doesn't attempt to redesign overall curricula but offers

a strategic master plan or framework to guide step-by-step and effective incorporation of AI concepts and technologies into existing programs. The study addresses issues of readiness of institution, curriculum gaps, international practices and local constraints but does not address the technical design and deployment of AI systems. Geographically, the study is only done in AATPC and may not reflect the case for other colleges although it would be a lesson that can be shared over similar contexts for developing countries.

1.7. Significance of the Study

The study becomes essential because it is a solution of modernization of the TVET at AATPC in response to worldwide technological advancements with a particular emphasis on AI. The advent of AI in the workplace has been changing practices and skills required for the industry in which the work is done. Thus, educational institutions of TVET are obliged to respond to this by updating their curricula. It is a contribution of the study by offering a systematic and context-specific framework as the initial stage of the gradual and proper utilization of AI in the curriculum of TVET to enable the learners acquire skills relevant to the digital economy. For education leaders and government policy makers, the study provides evidence based proposals that support strategic planning, policy development and education innovation investments. It aligns with Ethiopia's education sector reform and digital transformation program, offering actionable insights into how AI can be systematically and sustainably integrate into the country's national TVET system. This is essential if we are to meet our national goals for youth employment, industrial development and digital literacy. For curriculum developers and educational planners, it is to reduce the disparity between the old content of instruction and the skills required in modern industries. It reveals the importance factors of teacher capacity, infrastructure and educational curriculum for the use of AI in education. The framework also suggests key elements that will have to be addressed to make training relevant and adaptable to the rapid changes of technology. For instructors and institutional leaders in TVET, the study offers guidelines on how to integrate and utilize AI supported teaching and learning approaches. Through the implementation of the intelligent tools and personalize learning system or adaptive learning system instructors can increase learner interaction, individualize instruction and monitor performance more effectively. This leads to an effective and student-oriented learning environment that fosters better results.

The first and foremost long term benefit of students and graduates is the increase of employability and the capability to function well in a highly competitive job market. As AI technology becomes more and more integrated into various sectors, those who possess core skills and knowledge in AI will definitely have an edge over other graduates and thus putting their career on the fast track. Not only is the individual career is fast tracked, but also national productivity and innovation as well. Finally, this study adds to the contribute of literature on educational technology and vocational training by filling a gap in the literature of educational technology and vocational training in Ethiopia and provide a basis for further research on the integration of AI in TVET in developing countries that face the same challenges and opportunities.

1.8. Organization of the Study

The research is organized into six chapters. Chapter one introduces the reader to the study including the background, Motivation of study, problem statement, research questions, objectives, significance and scope. Chapter two is a literature review, a compilation of the different sources to support the researcher's work. It mostly explained AI concepts, applications of AI in education and some of the different ways to integrate AI with TVET. Chapter three describes the research design, sampling technique, data collection and procedures. The researcher explained the right way to make the artefact which is the proposed framework. In chapter four data presentation and interpretation or analysis, he talks about the analyzed data gathered through semi-structured interviews, focus group discussions, questionnaires and document analysis. Chapter five is based on the analysis and findings of this study where he proposes an AI curriculum for TVET and also presents validation and evaluation of this proposed AI framework in this chapter. There is also a chapter six dealing with conclusions and recommendations. The book list of references and appendixes are included at the end of the thesis.

CHAPTER TWO

LITERATURE REVIEW AND RELATED WORKS

2.1. Introduction

This chapter reviews the literature that led to the development of an AI integration framework for TVET curricula and this review forms the basis of the research. The study defines the concept, applications and potential of AI in education with particular reference to TVET institutes such as AATPC. In the beginning, the chapter outlines AI, its essential features including ML, NPL automation and also differentiates AI based learning tools from regular ICT applications. After that, it looks at the worldwide practices and experiences of the educational institutions in integrating AI which involves the accomplished frameworks and strategies for the integration of AI concepts in the TVET curricula. These global examples offer many useful lessons that can be a source of guide for adaptation in the Ethiopian TVET context.

The chapter then elaborates the socio-technical approach by explaining the close interaction of technology with the human side of the problem, institutional readiness and curriculum design. This review describes an example of how STS can contribute to the development of a holistic AI integration structure considering both technology infrastructure but also human factors like instructor skills and digital literacy in the student community. The study of the literature also has to do with the integration of the curriculum through TVET practices like competency-based learning, curriculum modernization and the alignment of the learning outcomes with the rapidly changing industry requirements driven by the era of IR 4.0 and the digital economy. The issues that hinder AI integration have been examined as well, such as limited infrastructure, lack of professional development for instructors, absence of policy support and resistance to change. The best practices and strategies to overcome these challenges have been discussed to inform the design of a context-specific AI integration framework.

Lastly, this chapter highlights the absence of research on integrating AI into TVET curricula in Ethiopia, mainly the lack of solid setups for systematically bringing AI into TVET curricula in Ethiopia. There's little guidance on how to do it effectively. These deficiencies in the literature

serve to validate the need for this study, which is intended to come up with a strategic, context specific framework for AATPC that can be effectively used in other public TVET institutions of developing countries.

2.2. AI Integration in TVET

A trend in the use of AI in education has attracted global attention because it helps students prepare for a 21st century workforce. As nations become increasingly automated, digitally built, and more connected, TVET systems have to adapt their curricula to meet industry and the world work or job market. Though much research is showing the importance of AI in training, competency assessment and skill development many TVET institutions particularly in developing countries are facing challenges in incorporating AI because of lack of digital infrastructure, lack of teacher training, lack of curriculum integration and lack of resources. This review therefore examines global trends in AI enhanced education best practices in vocational training modernization and theoretical foundations for curriculum integration. It also examines the challenges and opportunities in Ethiopian TVET institutions like AATPC where there is little use of AI in education despite the institution having a role in human resource development. Through summarizing these areas the review provides a framework for establishing a context-specific AI integration framework for AATPC [20].

TVET helps students acquire technical and practical skills that they will need on the job market. TVET has been called the engine of poverty eradication, employment and sustainable development particularly in low-income countries[22]. [21] suggests that modern TVET systems must be in tune with the needs of the labor market, make use of digital technology and promote lifelong learning. TVET in Ethiopia is a critical part of the national development agenda but it is poorly developed, lacks technology and teachers are poorly skilled.

2.1.1. Theoretical Foundation

In order for AI to be considered part of the curriculum of Ethiopian TVET, it is necessary to understand the theoretical basis of educational and technological practices in creating, implementing and using new ideas. Three perspectives that fit into the curriculum realities of AATPC serve as the theoretical foundation for this study. Constructivist Learning Theory

supports a shift from instructor-centered teaching towards learner-centered, problem-based and skill-based learning experiences in AI appropriate for TVET. The three perspectives that guide my research are Constructivist Learning Theory, the TPACK model and STS Theory [23]. The TPACK model guides me to understand how to incorporate AI into classroom teaching and content to make the use of AI in the classroom. STS Theory guides my research by acknowledging that successful implementation of AI in TVET requires people, culture, infrastructure and technology.

2.1.2. Constructivist Learning Theory

Constructivism emphasizes that students build knowledge that actively via experience, interaction and reflection. Constructivist theory in the context of TVET learning using AI supports learning by doing in simulated or real life situations where students engage with AI technologies and tools. The theory justifies the provision of experiential, problem solving learning approaches that enable student to develop critical thinking, creativity and practical AI skills. The transformation from rote learning to experiential learning supports TVET's competency based training approach, further enhancing the position of AI as a driving force of active, customized and contextualized learning[24].

2.1.3. Technological Pedagogical Content Knowledge (TPACK)

This model forms an essential basis of learning how teachers should implement AI based teaching and learning efficiently. It suggests that successful technology integration requires the Convergence of three knowledge domains: CK, PK and TK. In this framework TVET educators must not only are they aware of the AI principles (content) but also pedagogy and knowledge of applying AI systems and tools (technology). TPACK thus provides a systematic framework by which to design professional development curricula for TVET instructors so that they can teach AI augmented[25][26].

2.1.4. Socio Technical System Theory

STS theory provides a more general systems based approach to the embedding of new technologies within organizational settings. It puts a spotlight regarding the relationship between social factors including people, culture and structures and technical like tools, infrastructure and

systems. [27][28]. In the context of Ethiopian TVET, STS theory is alerting us to the need for consistent AI integration with institutional context, policy setting environments, stakeholder agendas and infrastructural conditions. STS theory is in favor of this holistic framework development process understanding that successful AI integration is not purely technical, but on system coherence and interplay among different actors.

2.1.5. AI in Education and its Importance to TVET

AI is the human intelligence re-created in devices capable of thinking, learning and improving themselves. AI's use in education include machine learning, natural language processing, robotics and AI based tutoring system [29]. Application of AI in education includes such as personalized learning, automated grading, Predictive analytics and administrative support. This can help students learn more effectively, engage students and support educators in their decision-making on the basis of data[30].AI in education includes using ML, NLP and other intelligent technologies to improve teaching and learning [31]. Some examples of the use of AI in education include intelligent tutoring, personalized learning, automatic grading and predictive analytics for learner achievement. AI can potentially change education because it can improve efficiency, make learning more personal and help teachers with administrative tasks. In TVET settings AI can be used in the simulation of real world industrial settings, adaptive learning for practical skills and forecasting skills for future labor needs[32]. Several countries have made progress in incorporating AI into their vocational and technical education [33]. For instance, China has invested heavily in developing AI curricula at the secondary and post-secondary levels of education including courses in AI such as robotics, data science and machine learning in TVET. In addition, digital transformation and AI literacy are skills that make up the vocational training programs of Germany's dual education system. Countries such as these offer an opportunity to explore a policy-driven strategy for integrating AI across government, industry and education [33].

AI refers to the incorporation of intelligent fields such as ML, NLP and data analytics to the educational area[34]. Various methods can be used by AI to influence the educational situation the process of learning and even the administration of educational institutions. Apart from that, AI in the TVET sector can be a great source for the development of intelligent tutorial system,

personalized learning platforms, automated grading system and predictive analytics to monitor student performance and forecast skill gaps [32]. To clarify, intelligent tutoring systems have the capability of supplying students with the feedback that is individualized and instantaneously. At the same time adaptive learning platforms have the ability to adjust not only the speed but also the content of the instruction depending on the prior knowledge and learning patterns of the learners. These categories of applications seek to make education more efficient but also, instructors get an opportunity to be more involved in the mentorship and practical guidance aspects of TVET which are very important. Furthermore, AI is given the responsibility of playing a major role in creating the industrial world for the training of the future through skills simulation. Thus, through virtual laboratories, AR, simulation based learning, students can learn how to handle complicated technical issues that might require expensive equipment or be a source of safety risk. To add that AI powered predictive analytics can be a very helpful tool in workforce planning as it can identify the skills and experiences that are about to develop and be essential in the labor market. Thus, TVET institutions can be able to prepare and change the curriculum accordingly[32].

AI also contributes significantly to the creation of industrial environments that mimic real life scenarios for the acquisition of practical skills. By employing virtual laboratories, AR and simulation safety-conscious students are given the opportunity to practice skills that would have to be performed with expensive equipment and which would pose safety risks. In addition to this, AI driven predictive analytics can become a pillar of workforce planning by determining the trends in skills and competencies that will be in demand in the labor market. This, in turn allows TVET institutions to not only react but also be proactive in revising their curricula[9].

Different countries have strategically and intentionally integrated AI into vocational and technical education thereby making available lessons to less developed contexts. In the case of China, the development of the AI curriculum has been executed in both the secondary and post, secondary TVET institutes where students are introduced to the modules on robotics, data science and machine learning. The evaluation of the programs indicates that they have enhanced the students' problem, solving skills and employability prospects. In Germany, literacy in AI and digital transformation is a part of a dual education system that involves classroom instruction and workplace training. But, this model also focuses for industry and educational provider's

collaboration to integrate AI to meet workforce demands in the real world. Singapore and South Korea both implemented AI-enabled personalized learning and assessments in their vocational training programs both of which have significantly improved student learning and training efficiency. These experiences show that the deliberate policy-driven integration of AI will only be possible through collaboration among the government agency, industry, stakeholder and educational institution. The challenges of AI implementation in TVET include lack of digital infrastructure, not enough teachers trained in AI tools, lack of money and concerns about data privacy [9]. Therefore, a framework for integrating AI in any setting should be aware of the realities and address the factors that affect the local environment, including technological, institutional and socio-economic aspects. It means that at AATPC for example, using AI for teaching and learning not only requires changing the curriculum but also needs infrastructure investment, professional development of instructors and collaboration with industry partners to ensure relevance and sustainability.

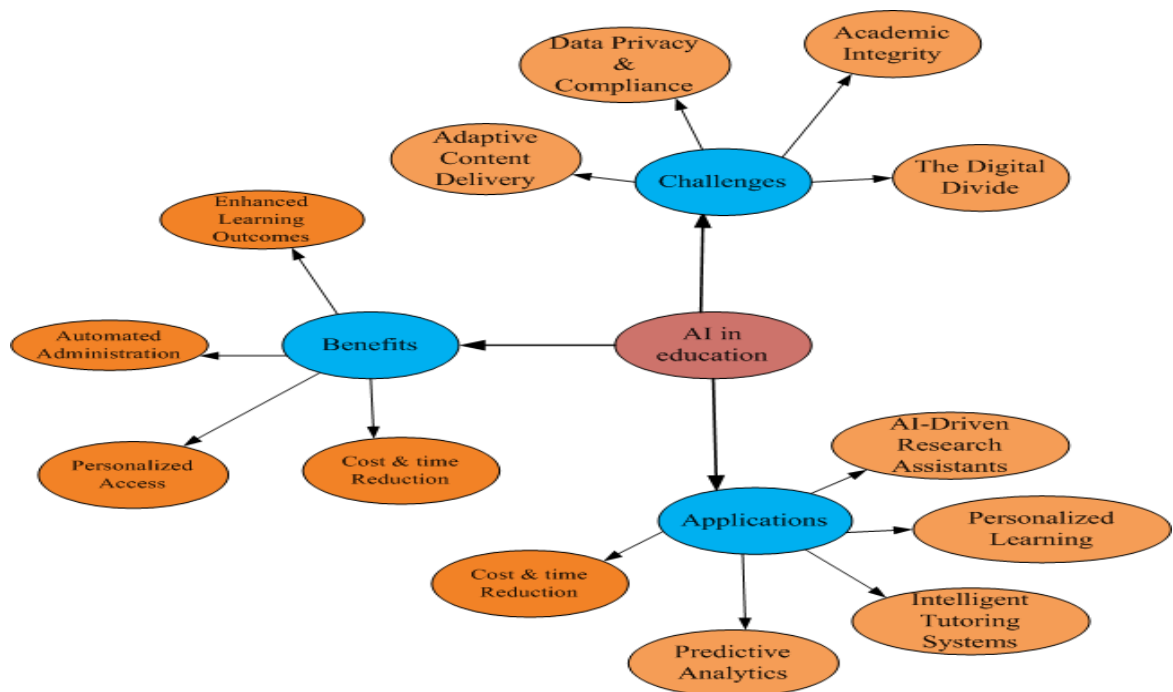


Figure 2.1: Multidimensional influence or impact of AI in education

2.1.6. Curriculum Reform and Framework Development

Curriculum reform is one of the central imperative for aligning educational systems to technological progress. AI uptake requires a redesign curriculum content, delivery, teacher competencies and assessment systems. UNESCO and World Economic Forum models emphasizing a competency-based approach that includes technical AI expertise along with communication and collaboration skill also ethical sensitivity. The literature highlights the imperative to contextualize such frameworks to local conditions so that reform are sustainable, inclusive and culturally responsive [9]. Also, AI is being integrated into the programs in TVET and thus there is a need to change the focus from the use of memorized facts to the development and use of skills that match the situations in the real world. This change is mainly needed in TVET programs, where skills and job readiness are the top priorities. Students need to be equipped with skills like reading data, understanding automation, solving digital problems and these skills need to be integrated into all the courses rather than being offered as separate courses. This way, they will be able to apply AI concepts into their respective fields like engineering, business, health. The role of the teacher has been expanded. The teacher is not only passing on the facts but is now involved in ensuring that the students discover and learn to apply AI technologies and tools. This requires the teacher to be trained so that they not only have the technical knowledge about AI but also the skills to apply the modern teaching methods. If the teacher is not trained, the lesson plan may not work the way they want. Industry requirements may also be a driving force for the content to be included in the curriculum[9]. This is because with the advent of AI the job market is changing. This requires schools to work hand in hand with companies. This may be beneficial in ensuring that the content being taught is relevant to the changing environment and the advent of new technologies. Ethical issues may be included in the curriculum to ensure that the students understand the implications and usage of AI. This may include issues such as biased AI, data breaches, and the overall effect on society. This may ensure that the students graduating from the courses have the ability to think extremely about the issues involved and the ability to make better choices regarding AI[35].

2.1.7. Challenges of Implementing AI in Developing Countries

Despite growing recognition of AI potential developing countries are faced with various challenges in implementing AI-powered education reforms. They vary from poor infrastructure

to limited qualified teachers, poor funding and resistance to change in traditional education systems. In the African context notes that the majority of TVET institutions are not digitally prepared and AI or related technologies are hardly incorporated. Ethiopia, in particular faces challenges such as limited internet connectivity, restricted rural access to electricity and the absence of national AI-specific educational strategies. However, within these challenges lies an opportunity to fast-track past legacy systems and design futuristic solutions from the outset[20].

2.3. Review of Literature Review

The global growth in the integration of AI in education has sparked empirical questions around its application at different levels of education. While industrialized countries have always adopted AI technology in formal education. For example, TVET in developing nations like Ethiopia are still at the preliminary level of exploring such integration. This section critically reviews empirical studies that use AI in education and TVET in particular, as the focus to inform the development of a local framework for integrating AI in Ethiopia [19]. A study by [36] in Singapore looked at integrating AI themed modules into vocational education curricula. The study found a positive impact on learners' resilience in coping with IR 4.0 technologies. Key enablers were government support, teacher training and curriculum reformation according to industry specifications. However, the high tech infrastructure of the context becomes a challenge to replicate in low resource contexts like Ethiopia without proper adaptation.

[37] Examined AI awareness in Nigerian vocational institutions. Their qualitative data presented evidence of low AI understanding among students and teachers. Despite infrastructural limitations the research also revealed a strong willingness among the stakeholders to adopt AI if they were provided sufficient training and resources. This can be especially relevant for Ethiopia which also has similar infrastructural and capacity-related issues in its TVET. A regional perspective was given by [13] in a study assessing digital transformation readiness in Addis Ababa TVET colleges. Although not entirely focused on AI the study showed a favorable attitude toward digital technology among teachers and students. However, it also highlighted significant drawbacks like inadequate ICT infrastructure, inadequate training on emerging technologies and weak institutional strategies for digital integration.

A cross country study conducted in Sub Saharan Africa by [38] focused on AI preparedness in the region. They found that while AI application in education is more in vogue the TVET sector remains underrepresented in policy and practice. The study called for designing frameworks to address localized imperatives like infrastructure development, training of teachers and aligning curricula with local industries.

In addition, a survey by [13] Studies indicate that many Ethiopian TVET instructors recognize the importance of digital and emerging technologies such as AI for future workforce needs yet there are significant gaps in formal digital skills training and professional development among instructors. This gap highlights the need for institutional policy reform and well-organized professional development programs to support effective AI integration in TVET.

Generally, current empirical data in 2016 and beyond show growth in global interest in AI for education but point to vocational sector lag, particularly in Sub Saharan Africa. Although world models exhibit the potential of AI in improving learning achievements and related curricula with emerging industry needs, empirical data from Ethiopia reflect a significant lag in AI preparedness and integration in TVET. This requires the development of a context-specific framework for AI integration appropriate to the situation, limitations and potential in the Ethiopian TVET context [39], [40].

Table 2.1: Related Works

No	Author(s), Year	Study Title / Context	Key Findings	Relevance to This Study
1	UNESCO (2019)	AI in education: obstacles and prospects for long-term growth	AI supports personalized learning, institutional efficiency and skills development but requires ethical governance and infrastructure readiness.	Provides global policy justification for structured AI integration in TVET curricula at AATPC.
2	Holmes, Bialik, &	AI in education: potential benefits	Effective AI integration requires pedagogical transformation,	Informs curriculum integration

	Fadel (2019)	and consequences for instruction	teacher training and curriculum redesign.	strategies and human capacity development in the framework.
3	OECD (2021)	Opportunities, threats and policy implications of AI in education	Governance, digital infrastructure and institutional readiness determine successful AI adoption.	Supports inclusion of governance and institutional readiness in the framework.
4	Luckin et al. (2016)	Intelligence unleashed: An argument for AI in education	AI enables adaptive learning systems and intelligent tutoring when aligned with pedagogy.	Guides AI-enabled instructional design for TVET curriculum integration.
5	Selwyn (2019)	Should educators be replaced by robots? AI and education's future	AI should support, not replace teachers; human-centered integration is essential.	Reinforces socio-technical and human-centered framework design.
6	African Union (2022)	Continental AI strategy for Africa	Emphasizes AI capacity building, infrastructure development and education reform.	Provides African contextual justification for AI integration in Ethiopian TVET.
7	FDRE Ministry of Education (2020)	Education development roadmap (2018–2030)	Focuses on digital transformation, TVET reform and technology-enhanced learning.	Anchors framework in Ethiopian national education policy.

8	Ethiopian TVET Agency (2020)	National TVET strategy document	Promotes competency-based education, digital skills and industry alignment.	Aligns AI integration with national TVET objectives at AATPC.
9	Owolabi et al. (2022)	AI readiness in polytechnic libraries (Nigeria)	Moderate AI awareness but major barriers include ICT gaps, low literacy and limited infrastructure.	Justifies need for context-specific AI integration framework in Ethiopian TVET.
10	Tadesse & Belay (2023)	AI applicability in Ethiopian TVET (FTVETI case study)	AI improves learning outcomes, engagement, and administrative efficiency; training is essential.	Supports urgent need for institutional reform and AI capacity building.

2.4. Summary

The embedding of AI in Education, especially in TVET programs, can not a matter of choice anymore but a strategic tool for a country's economic growth, industry needs and upgrading of institutions. Global reports and studies undertaken by UNESCO (2019), OECD (2021) and Holmes et al. (2019) emphasized that effective AI embedding in Education can be achieved through good governance, ethics, digital infrastructure development and teacher training. However, these can only be addressed if considered a holistic approach rather than an isolated one, recognizing that AI embedding is an organizational change process as much as a technical one. In fact, the integration of AI is always considered to be socio-technical in nature and the sole integration of technology is not sufficient to bring the desired changes without the alignment of institutional culture, leadership, teacher competencies and education policies (Selwyn, 2019; Luckin et al., 2016). Though the awareness and inclination towards the integration of AI in the institutions of vocational education across Sub-Saharan African countries are highly positive, the challenges faced with low AI literacy, poor ICT infrastructure and inadequate technical

competencies. Remain the barriers to the integration of AI (Owolabi et al., 2022). In the African region as well as Ethiopia the policy guidelines and research studies (African Union, 2022; FDRE MoE, 2020; Ethiopian TVET Agency, 2020) highlight the significance of the formulation of indigenous policies to overcome the challenges faced with the integration of AI in the region such as infrastructural limitations, skills shortages, institutional unpreparedness. Research studies conducted in Ethiopia indicate the positive impacts of the integration of AI in the institutions of vocational education with regards to the motivation of students, the quality of learning. As well as the limitations faced with the integration of AI (Tadesse & Belay, 2023). However, as much as there is literature worldwide and regionally focusing on AI in the context of education it is generalized, third-party and context-neutral failing to consider the local institutional capabilities socio-economic factors and policy environments of various institutions especially in colleges like AATPC. Thus, it is important to develop a context-specific AIIF, integrating aspects of governance, infrastructural development, human resource development, curriculum transformation, ethics and innovation into one framework specific to the Ethiopian context while at the same time being aligned to global best practices in AI development.

2.5. Research Gap

A global and national literature survey on AI integration in the technical and vocational education sector shows that this work intends to fill a number of key gaps. Firstly, the present integration frameworks of AI at the international level necessitate resource rich and technologically advanced environments which are far from the infrastructural and technological realities at AATPC. Second, despite their awareness of the need for AI skills for future employment very few teachers have received digital or AI training indicating a significant lack of preparedness. Thirdly, the existing TVET curriculum is still mainly teacher centered and competency based with very few mentions of AI automation or Industry 4.0 skills thus limiting the use of AI supported pedagogies. Fourthly, national policies such as Ethiopia MoIT Digital Strategy 2025 just give practical guidance for AI implementation thus creating a policy practice gap. Lastly, socio-technical issues which include the integration of human, organizational and technological aspects as well as stakeholder engagement are generally overlooked in the studies. This study addresses these gaps by developing a contextually improved AI integration framework for

AATPC based on international best practices, socio-technical theory, national policy documents and empirical research. It supports the curriculum alignment, faculty capacity building, infrastructure improvement and stakeholder engagement through the strategic alignment of the framework to depict local infrastructural, pedagogical, institutional and socio-technical conditions, thereby providing a context-specific framework for AI adoption in Ethiopian TVET institutions. In general, there is a shortage of localized frameworks that include all parts of the curriculum institutional readiness, human capacity, curriculum and pedagogical integration, stakeholder collaboration, technological infrastructure, data management governance and ethical and legal policy for AI in Ethiopian TVET institutions. This gap serves as the main reason for which a comprehensive and locally contextualize AI adoption framework is urgently needed at AATPC so as to be able to orient global AI innovations to local realities increase graduate employability and facilitate the digital economy that Ethiopia is gradually stepping into a digital economy. Addressing this gap also aligns SDG 4 on Quality Education in the 2030 Agenda for Sustainable Development which emphasizes developing relevant skills, technical competencies and inclusive technology enhanced education to prepare learners for the demands of the future workforce.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

Methodology refers to the approach or set of methods employed to produce the expected results such as knowledge, insights, designs or practical solutions [41][42]. In information systems research Design science and behavior science are the two approaches. The goal of behavioral science is to understand how individuals and groups think within their own systems. Design science is about producing things that will better human and social capabilities. This study is DSR based because it involves developing and evaluating new technologies and sociotechnical solutions and thus it is the best choice to devise a framework for AI implementation in TVET colleges [42]. A primary goal of the study is to develop an AI integration framework that will help the effective integration of AI into curriculum, teaching, learning and institutional practices at TVET colleges (specifically at AATPC) including tools, platforms and infrastructure. The framework also addresses the social dimensions of curriculum pedagogy, staff capacity and stakeholder engagement. The study first examines the problem and motivation for the study. This involves looking at the current state of AI integration at AATPC characterized by low AI literacy, insufficient technology, inadequate teaching as well as learning and no policies. Next, the research determines the solution that would involve raising student and teacher AI literacy, encouraging the use of AI-supported teaching and learning enhancing institutional capacity for AI integration, and maintaining sociotechnical alignment.

The study begins with problem identification and motivation. This involves examining the current state of AI integration at AATPC. Key challenges identified include low AI literacy, insufficient technical infrastructure, limited pedagogical adaptation and inadequate institutional policies. Next, the research defines the objectives of the solution. These objectives include raising AI literacy among learners and instructors, encouraging the use of AI- supported teaching and learning methods, upgrading institutional capacity for AI integration and maintaining socio-technical alignment sustainably.

The design and development stage is to develop the AI framework using technical, pedagogical and organizational factors that can be readily incorporated into practice. To do this, the framework is demonstrated through simulated scenarios, expert reviews and stakeholder feedback from selected TVET colleges AATPC. Framework is assessed for assessing completeness, ease of use and usefulness in solving identified problems. Ideas are collected from curriculum developers, instructors, students and administrators to assure that the components of the framework can be easily adopted. The research results, including the design of the framework and recommendations are then shared with policy makers, teachers and curriculum developers to develop a plan for the seamless integration of AI at AATPC. Through the DSR approach, this research aims to produce a verified that is appropriate AI framework that would help improve learning, foster innovation and promote the long-term adoption of AI by Ethiopian TVET colleges.

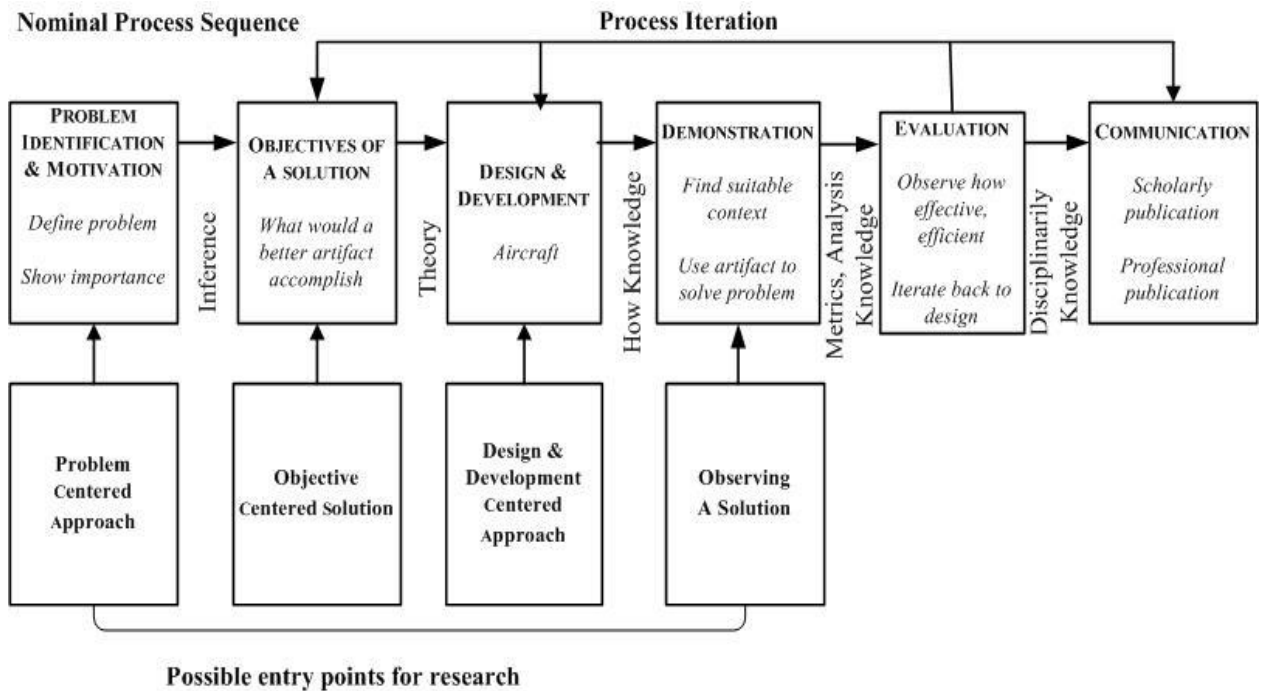


Figure 3.1: Design Science Research Methodology Process Models (Peppers et al., 2006)

3.1.1. Research Approach

This research uses a design science approach which fits for the creation of new artifacts like a socio-technical AI framework that combines the technical and social aspects to address real world issues[43]. The reason is that the main focus is on the design, evaluation and refinement of a

framework not on testing numerical hypotheses. Qualitative research method is supported by expert validation and qualitative methods offer the possibility of systematically understanding the difficulties needs and practices concerning AI integration in Ethiopian TVET colleges and also the views of various stakeholders such as instructors, students, administrators and Curriculum Developer. The research employs purposive sampling to identify participants who are in the frontline of AI related initiatives or decision making AATPC. These are lecturers teaching technical subjects, college administrators responsible for the curriculum and technology adoption and AI professionals who can provide expert insights regarding the deployment of AI tools in education. By focusing on participants with the relevant experience and knowledge the study ensures that the collected data are appropriate for designing a contextualized AI integration framework. This research adopts a mixed-method research design combining both quantitative and qualitative approaches to achieve a comprehensive understanding of the factor influencing AI integration in the TVET curriculum at AATPC. The study is conducted as a case study of AATPC allowing for an in-depth analysis of the institutional context. Furthermore, the study follows a design science approach to develop and propose a contextualized AI integration framework. In this regard, Quantitative data are used to assess patterns and level of readiness while qualitative data provide deeper insight into challenges and contextual factors. The integration of these approaches ensures a systematic analysis and supports the development of a practical and context-specific framework.

The mixed approaches study design can provide contextual information relevant to the research on the context and provide measurement information relevant to teacher skills, curriculum changes, technological infrastructure, ICT policy and sustainability. To achieve this goal a single detailed investigation of AI integration within AATPC was done with the help of the case study method. A case study means very close and detailed observation of a particular organization to know its processes and problems thus getting the ideas and generalizations from it. This method is especially good when you want to understand deeply how different layers like institutional, human, technological interact and affect each other in the case of AI adoption. The qualitative research involves gathering the deep richly detailed and very pertinent data through semi-structured interviews, focus groups and document analysis with the key stakeholders (TVET teachers, students, college staff).

This enabled them to identify what facilitates, hinders and the perception of AI integration in the first place which thus serves as a direct guide to the teacher training, curriculum design and institutional policy making decisions. Along with this the quantitative part used structured questionnaires that were given to a bigger and more diverse group of TVET instructors and students. This helped in measuring AI awareness, usage patterns, infrastructural readiness and perceived benefits. Thus providing statistically robust evidence that supports the qualitative findings. Combining qualitative and quantitative methods resulted in a coherent and comprehensive understanding of the factor that underlies AI integration at AATPC. This integrated approach offers the required evidence to shape a feasible, locally sensitive AI integration framework for the TVET curriculum that would take care of curriculum revision, teacher capacity, technological infrastructure, policy guidance and continuous improvement.

The design science research strategy chosen for this study is DSR as the primary deliverable is an artifact, a context-specific AI integration framework for the TVET curriculum at AATPC. DSR case studies also provide the empirical information for Problem Identification and Evaluation: quantitative survey data ($n = 67$) to assess awareness of AI, institutional readiness and infrastructure and qualitative data obtained from semi-structured interviews, focus-groups, observation and document review to understand stakeholder perceptions, institutional barriers and contextual constraints. Combining these two streams of data further enrich the data for Design and Development (Chapter 4) and Evaluation (Chapter 5). DSR, mixed methods and the case study design are therefore at three different levels strategy, data and unit of analysis not paradigmatic mixing as [44] suggests.

3.1.2. Data Collection Methods

Primary and secondary data sources are considered. The primary data sources are mainly questionnaires, interviews, group discussions and observation. While for secondary data a review of policy documents, curricula and institutional reports in relation to AI in Education digital transformation in TVET and 21st century skills will be reviewed in more detail. The primary data is obtained from instructors, department heads, IT staff, Administrator/staff and students of AATPC as well as relevant stakeholders from the TVET governing body.

3.1.3. Primary Data

The research assistant used observation, semi-structured interviews, questionnaires and group discussions.

- **Semi-structure Interview**

Researchers might gather information from semi-structured interviews to compare and contrast with information from other interviews [44] . Interviews will be held with IT staff, academic department heads, TVET instructors, TVET stakeholder and curriculum developers to identify technological, pedagogical and institutional facilitator and obstacles to AI integration and to get diverse views on the components of a practical and sustainable AI framework for the TVET context.

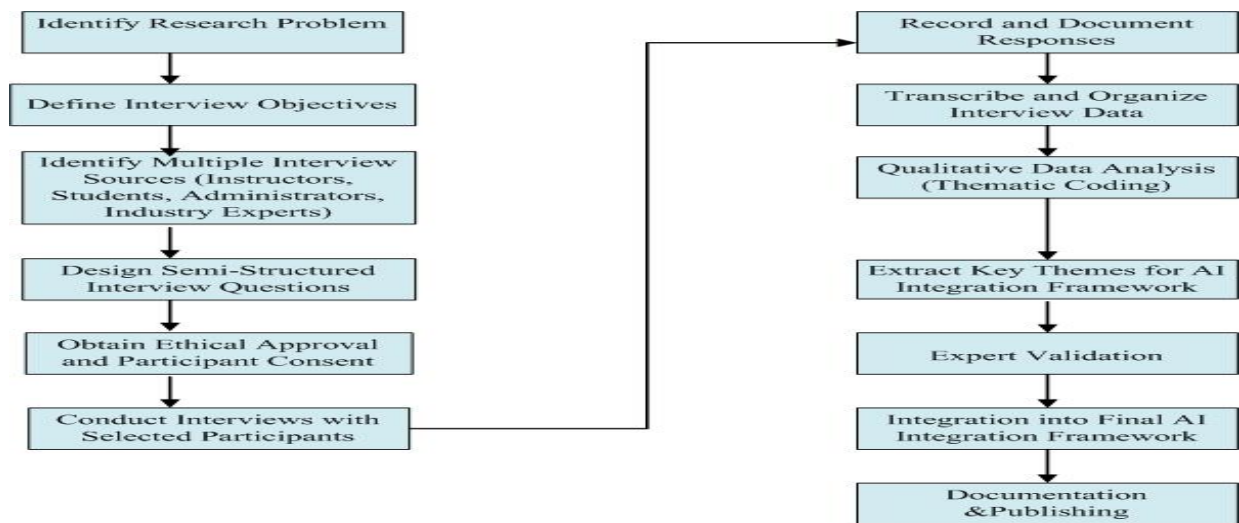


Figure 3.2: Interview process of the research to reach multiple sources

- **Group Discussion**

Discussion groups or group interviews are also known as Focus Groups. Individuals are gathered in a group to discuss a particular issue [45]. Conduct focus group discussions among instructors, students and industry partners to identify current perceptions, practical challenges and potential strategies for integrating AI into the TVET curriculum. The benefit of using focus groups is that

a common understanding of group norms can be gained and a variety of interactive responses to the discussion can provide insight that may not surface in individual interviews.

- **Questionnaires**

When gathering structured data from a large number of participants in an organized manner is the goal, a questionnaire is a very common and helpful research tool. With the help of a questionnaire a researcher can quantitatively determine a participant's level of knowledge the attitude, perceptions and experiences of a particular issue based on the responses given. In an attempt to find out the awareness level of the faculty and students of Artificial Intelligence their digital skills, the institution's willingness and the major challenges as well as opportunities for the integration of AI in the TVET curriculum, structured questionnaires were distributed to instructors, students and academic staff of AATPC. The use of questionnaires standardizes data collection allows for easy comparison of different respondent groups and permits statistical calculations to be made on the respondents' answers. Apart from that a questionnaire is a cheap instrument and it saves time which therefore makes it an easy tool to be used in the collection of broad perspectives that could be used to compliment the qualitative findings from focus group discussions and interviews[46].

3.1.4. Secondary Data

Secondary data refers to existing data that can be easily obtained and that is associated with a previous observations. These secondary data are considered to be useful in establishing comparisons and validating primary findings. Secondary data are classified into internal secondary data and external secondary data. Internal secondary data is data that has already been created by the organization itself, such as existing curriculum documents, institutional reports and past strategic plans of AATPC, gathered to constitute a verifiable data source. External secondary data are studies that have been published or are in the process of being published within the researched area of AI in education and TVET reform and are indispensable to the spread of the specific knowledge and evolution of the research. Moreover, Secondary data should be easily accessible, accurate and pertinent in order to help solve the issue. Primary data can be used to help understand and explain the study problem in addition to providing facts. Books, papers, journal articles, internet data sources and webpages are further types of secondary

data[47]. Secondary data used in this thesis has been collected via the internet, journal articles and reports. Secondary data used in this study has been taken from the official site of the AATPC, MOLS and other education and technology sites.

3.1.5. Research Population and Sample Size

The research focuses on key stakeholders at AATPC who are directly involved in curriculum delivery, institutional management and technological support. These stakeholders include students, lecturers, department heads, administrative staff, IT support staff, curriculum developers and policymakers. The research is limited to AATPC due to its diversity in program offerings readiness for AI initiatives and strategic relevance for the study. Since the goal of this research is to develop a framework for contextual AI integration. The aim was to collect the detailed data not make generalizations from overseas. To this end, I conducted a purposive sample to select individuals who had relevant experience, knowledge and experiences with AI and curriculum activities so that these responses would inform the structure of the framework. The qualitative research participants gave many opinions through interviews, focus groups and document reviews of instructors from ICT, Electrical & Electronics, Automotive, Garment & Textile and Manufacturing, department heads, ICT support staff and curriculum developers. A smaller survey was administered along with the qualitative research to as part of the qualitative data to get current awareness about technology, infrastructure use and technology use by college students. With 67 valid responses the smaller survey was administered and used for analysis. The research at AATP required a case study as it examined the incorporation of AI to both the institution and in the curriculum. It was directed to instructors from technical departments such as ICT, Electrical & Electronics, Automotive, Garment & Textile and Manufacturing as well as department heads and ICT support staff. The goal population for this research was 72 individuals. 67 completed and valid responses were gathered and used for data analysis. It was a good number of responses and a good database for the AI integration framework. In addition to quantitative sample, a qualitative sub-sample from the population was also drawn to gain insights into the practice of AI integration. This included four semi-structured interviews with department heads and senior instructors and two focus group discussions (FGDs) each with 6-8 participants (students and instructors from different departments). The interviews lasted between 2 hours and

the focus group discussions ran between 60 and 90 minutes and focused on interviewing participants about their experiences, perceptions and concerns with AI integration in TVET.

Table 3.1: Target Population.

No	Department/ Organization	Gender		Total	Education Level					Remark
		M	F		L3	L4	Degree	Master	Other	
1	Level 3 Student	12	4	16	16	0	0	0	0	
2	Level 4 Student	18	6	24	0	24	0	0	0	
3	Staff/Admin ,Instructor)	20	12	32	0	0	21	10	1	
	Total Population			72	16	24	21	10	1	

3.1.6. Data Analysis Techniques

The study of the data is going to be a combination of qualitative and quantitative methods to understand deeply the factors impacting the use of AI in the TVET curriculum. The qualitative data to be analyzed will be derived from interviews, focused group discussions and open ended questions. The analysis will proceed through a systematic thematic analysis using python program reflecting all stages of the process getting familiar with the data, data entry, variable coding and creating themes, reviewing themes, defining and naming themes and writing the analysis. This will help to recognize patterns, common experiences and main difficulties of AI integration faced by instructors, students, administrative staff and curriculum developer. Thus, from their own viewpoints. The quantitative data gathered through the questionnaires will be allocated with using software. The quantitative data collected from the questionnaire will be analyzed using descriptive statistics with statistical packages for social scientists (MS excel 2016, SPSS v27.0) and may include frequencies and percentages.

3.1.7. Sampling and Data Collection Procedures

This study employed a purposive sampling technique to select participants who have relevant knowledge and experience related to AI integration in TVET education. Purposive sampling was

chosen because it allows the selection of information-rich cases that can provide in-depth insights into the research problem[48].

3.1.8. Sample Size and Participants

The study uses a mixed-methods data collection approach:

- A total of 72 questionnaires were distributed and 69 were returned of which 67 were valid and used for analysis.
- 14 semi-structured interviews were conducted with key informants, including department heads and senior instructors.
- 2 focus group discussions (FGDs) were conducted each consisting of 6-8 participants drawn from students and instructors.

This combination of quantitative and qualitative participants ensured a comprehensive understanding of AI integration from multiple stakeholder perspectives.

3.1.9. Inclusion Criteria

Participants were selected based on the following criteria:

- Being a student, instructor or administrative staff member at AATPC TVET College
- Having direct involvement or exposure to teaching, learning, or institutional ICT systems
- Willingness to participate voluntarily in the study
- Ability to provide informed and relevant insights regarding AI awareness, readiness and challenges

These criteria ensured that only participants with meaningful exposure to the TVET environment were included in the study.

3.1.10. Methods of Data Analysis

Validity and reliability are two of the most important characteristics when evaluating measurement tools. Validity determines if a tool measures the concept that it is supposed to measure or not[48].

A content validity test was carried out in this research. Content validity refers to the degree to which

a measuring instrument represents the entire range of material that is under study. The data collection instrument was dispatched to a total of 40 trainees and 28 staff members (who have practical experience in TVET College teaching and learning), four academicians with a cover letter for their comments (to change unclear/ambiguous questions, eliminate unnecessary questions and add additional questions if necessary). Based on the reviewers' comments, some ambiguous questions were changed the order of some questions was changed and one question was removed from the list. Reliability refers to the extent of a data collection tool to yield the same results consistently[48]. After the final instrument was approved by the advisor, a pilot study was carried out with 11 respondents from AATPC TVET Colleges. According to [49], pilot study sample size should be at least 15% of the expected sample size in the main study. For the purpose of this research 15% of the pilot study sample were engaged to test the reliability of the instrument (questionnaire).

Table 3.2: Cronbach’s alpha results from the pilot test (Source reliability test 2020)

Case Processing Summary					
		N	%	Reliability Statistics	
Cases	Valid	11	100.0	Cronbach's Alpha	N of Items
	Excluded ^a	0	0.0		
	Total	11	100.0		
a. List wise deletion based on all variables in the procedure.					

The internal consistency of the questionnaire was assessed by Cronbach's Alpha with a coefficient of 0.988 (excellent reliability) although values higher than 0.95 (highly similar scale items) may indicate item redundancy (the items in the scale are very similar). We feel this high reliability is acceptable given that our instrument is designed to measure closely related constructs such as AI integration readiness, awareness and institutional factors. The internal consistency of the questionnaire was assessed using Cronbach’s Alpha, which yielded a coefficient of 0.988 indicating very high reliability.

The alpha value there is normally between 0 and 1. The higher the Cronbach's alpha coefficient there is, the more internal consistency of the items is. [50], [51] alpha values above 0.70 is accepted. Table 3.2 provides results of the internal reliability of the test. The internal reliability of the test results in Cronbach's alpha coefficients of 0.988 suggesting excellent internal consistency indicating that the survey instrument there is reliable and will produce consistent results. The pilot test was successful and the final survey instrument (questionnaire) was distributed to 72 respondents along with a cover letter explaining the purpose of the study and confidentiality of data collected from them. The survey questionnaire consists of 5 demographic questions and 67 items for importance of AI and TVET College respectively.

3.2. Design and Development

In this stage, the study objectives to develop an artifact in the form of an AI integration framework contextualized for TVET institutions specifically AATPC. In design science research an artifact may include a framework, model, concept or method that represents a research contribution within its approach. Next identifying the objectives of the result, the offered AI integration framework is developed centered on previous works related to artificial intelligence in education, STS theory, curriculum integration and digital revolution institutions. The framework is designed to address the contextual needs, institutional capacity, technological infrastructure and stakeholder readiness of AATPC.

3.3. Demonstration

Demonstrate the use of the artifact to solve one or more instances of the identified problem. The researcher uses the developed AI Integration Framework to address the existing challenges of integrating AI into the TVET curriculum at AATPC in a better and more structured manner to demonstrate that the proposed idea works. Resources are needed to show the use of the framework for institutional and curriculum issues. The researcher collects data using quantitative and qualitative means. Using primary and secondary data sources are used in this research.

3.4. Research Design

The conceptual framework used to conduct a study is known as research design. [52]. Therefore, for this thesis the researcher employs approach structure that supports the creation, development

and validation of an AI integration framework suitable for the TVET context. The study adopts a DSR design as the main purpose is to create a contextual and novel structure that deals with both the pedagogical and technical requirements of integrating artificial intelligence into the AATPC curriculum. This design enables the researcher to discover the current challenges and extract relevant information from stakeholders, develop an integration strategy for AI and validate it with an expert review and contextual analysis. The process of problem identification, system design, demonstration, evaluation and communication is all made in accordance with the actual needs and institutional environment of AATPC.

3.5. Evaluation

In this study the evaluation step is quite important. The first goal of this stage is to assess the completeness, relevance to solving the problem and integration with the existing system of the AI integration framework in solving the problems identified in the TVET curriculum through this study. The evaluation refers to the comparison of the proposed solution's goals with the actual outcomes achieved during the demonstration. It is through this comparison process to find out if the framework is feasible, relevant and able to facilitate the application of AI in the teaching learning environment. Most importantly, key experts such as instructors, department heads, curriculum developer and ICT professionals at AATPC are involved in the validation of the proposed AI integration framework.

Evaluation takes place over two distinct phases. Initially, the experts are shown the draft framework and their reaction is collected in the form of feedback and suggestions concerning not only the structure and the elements but also the practicability of the framework. Their suggestions are used to enhance the framework and move on to the next stage of review using the usual analysis. The framework's utility coverage, alignment with the institutional context, clarity and suitability of the components and overall implementability as a means of integrating AI in TVET curriculum are the four main dimensions on which the assessment is conducted. The evaluation criteria are derived from well-established studies[53].

3.6. Communication

Effective communication of research results is one of the most important factors in making sure that the problem, proposed solution and the consequences are clearly understood by all relevant stakeholders. The main issue that this research is dealing with is the gap of practical and conceptual guidance for the integration of AI into the TVET program at AATPC. Not only is this problem being identified but it is also being examined in terms of how it affects the quality of education, the efficiency of institutions and the development of a skilled workforce that is ready for a technology-driven economy. The AI integration framework as a main artifact is introduced as an instrument of the systematic approach of AATPC in carrying out implementation of AI within its curriculum namely stressing technological readiness as well as social contexts. What is brilliant about the framework is that it has been specifically designed for the Ethiopian TVET sector and it combines the international best practices of AI integration with the particular institutional, cultural and operational realities of AATPC. Its credibility is evidenced by a well-organized design procedure, extensive stakeholder discussions and compliance with AI adoption and educational technology integration standards. The framework's results are communicated by means of evidence based validation that includes actual examples, case-based evaluations as well as giving practical suggestions for TVET curriculum implementation. The dissemination of the results is planned for researchers, Curriculum Developer, educators, Staff/Admin and students who are instrument in knowledge transfer thus not only increasing academic understanding but also improving practical aspects of AI integration in Ethiopian TVET institutions in general and at AATPC in particular.

3.7. Ethical Consideration

The study will utilize the institution's letter of recommendation. The researcher must remain ethical during interviews and focus group discussions by maintaining confidentiality and respecting community members especially the elders. The researcher must respect participants' right to privacy and the results will be anonymized. Data collection will be done only with the consent or agreement of the respected bodies. The researcher will promise to provide a copy of thesis work to the organization that will implement it. Finally, the data collected from the AATPC will be used only for teaching purposes.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1. Introduction

This chapter reports the results along with a discussion. In the results section, the study findings derived from the methods of data collection are presented. The discussion gives an interpretation of the significance of the findings compared to the research question based on the information obtained through the interviews and questionnaires of the key informants. Each table contains a synthesized description based on the information the researcher obtained.

4.2. Response Rate

To develop the AI integration framework for TVET colleges the researcher distributed a total of 72 questionnaires to the selected respondents based on the sample of the study. Out of these 69 questionnaires were returned while 3 were not returned. From the 69 returned questionnaires 2 were excluded from analysis due to incompleteness. Therefore, 67 questionnaires were found to be valid and used for data analysis. This represents a response rate of 93 percent which is considered acceptable for statistical analysis.

4.3. General Information

4.1.1. Respondents' Gender

Table 4.1: Gender of Respondents

		Frequency	Percent
Valid	male	45	67.2%
	female	22	32.8%
	Total	67	100.0%

Gender breakdown of respondents in the above table 4.1 show that 45 (67.2%) males and 22 (32.8%) female employees and students.

4.1.2. Respondents' Educational level

Table 4.2: Respondents' Educational level

		Frequency	Percent
Valid	level 3	11	16.4%
	level 4	24	35.8%
	degree	21	31.3%
	master	10	14.9%
	other	1	1.5%
	Total	67	100.0%

Table 4.2 above indicates respondents' educational level. Of the total respondents, 16.4%, 35.8% and 31.3% are level 3, level 4 and degree holders respectively, 14.9% and 1.5% are masters and others.

4.1.3. Job Category of the Respondent

Table 4.3: Job Category of the Respondent

		Frequency	Percent
Valid	Management	4	6.0%
	Senior	8	11.9%
	Junior	12	17.9%
	Officer	8	11.9%
	Student	35	52.2%
	Total	67	100.0%

Table 4.3. Above shows among the respondent's, students cover the highest percentage of 52.2% followed by junior level staffs with 17.9%, officer level staff with 11.9%, senior level staff with 11.9%, management level staff with 6% respectively.

Table 4.4: Frequency Analysis of Personal Awareness & Skills (Human capacity)

Human capacity (FMC1)			
Question	Response	Count	%
Q1. Familiarity with AI			
	Very Low	5	7.5%
	Low	15	22.4%
	Medium	28	41.8%
	High	11	16.4%
	Very High	8	11.9%
Q2. Have used an AI Tool (e.g., ChatGPT)			
	Yes	45	67.2%
	No	22	32.8%
Q3. Self-Rated Digital Skills			
	Very Low	4	5.9%
	Low	8	11.9%
	Medium	37	51.4%
	High	13	18.1%
	Very High	5	6.9%
Q4. Have you used AI tools for educational purposes?			
	Yes	62	86.1%
	No	10	13.9%
Q5. What is Machine Learning?			
	Computer hardware	4	6.0%
	Programming language	8	11.9%
	AI systems that learn from data	37	55.2%
	Internet connection	13	19.4%
Q6. What does "algorithmic transparency" mean in educational AI?			

	a. AI systems should clearly show how they generate results and recommendations	41	61.2%
	b. All AI code should be open source for public review	18	26.9%
	c. Students should understand when they are interacting with AI	8	11.9%
Q7. AI technologies and tools used in teaching/learning activities?			
	Generative AI tools (ChatGPT, Deep seek, Gemini etc.)	51	76.1%
	AI powered learning management systems	1	1.5%
	Automated assessment and grading tools	2	3.0%
	Machine learning platforms	7	10.4%
	Adaptive learning platforms	4	6.0%
	AI-powered presentation tools	2	3.0%
Q8. Are staff and students trained on AI tools and ethics?			
	Yes, regularly	11	16.4%
	Sometimes	20	29.9%
	No, never	33	49.3%
	Other	3	4.5%

The Human Capacity (FMC1) measures the respondents' knowledge, digital skills, understanding and usage of AI and training experiences with the integration of AI in TVET education. For general knowledge about AI 41.8% of respondents said they are medium familiar with AI while 22.4% and 7.5% indicated low and very low familiarity respectively. 16.4% and 11.9% of respondents indicated high and very high levels of familiarity. For use of AI tools, 67.2% of respondents indicated that they have used AI tools such as ChatGPT and 32.8% had no use of AI, 86.1% confirmed that they have used AI tools to teach and 13.9% said they did not have used them for anything educational purpose. For digital skills 51.4% of respondents rated their skills as medium whereas 11.9% and 5.9% described their skills as low and very low respectively. The remaining 18.1% and 6.9% indicated high and very high levels of digital

competence. In addition, there appears to be varying level of understanding regarding the meanings of AI. For example, 55.2% of respondents correctly defined machine learning as AI systems that learn from data while 44.8% answered wrong. 61.2% of respondents correctly understood algorithmic transparency as AI systems that explain how outputs and recommendations are generated with the rest having limited or incorrect understanding of the AI tools used in teaching and learning generative AI tools like ChatGPT were most commonly used (76%) followed by machine learning (10.4%) adaptive learning platforms (6%) AI-powered presentation tools (3.0%) automated assessment tools (3.0%) and AI-based learning management systems (1.5%). For responses on training 49.3% of respondents did not formal AI training 29.9% only once a year and only 16.4% of respondents had regular training. These descriptive findings suggest a moderate level of AI awareness and practical exposure among respondents particularly through the use of generative AI tools. However, the concentration of responses around the medium category of familiarity and digital skills indicates that while basic awareness exists advanced competence in AI remains limited. The high rate of AI tool usage alongside moderate knowledge levels suggests that AI adoption is largely informal and self-directed rather than systematically guided by institutional training or structured programs. This gap between practical use and theoretical understanding is further reflected in the limited understanding of machine learning and algorithmic transparency which are essential for responsible and effective AI utilization in education.

Moreover, the dominance of generative AI tools compared to other educational AI systems indicates that respondents primarily engage with easily accessible applications rather than integrated institutional AI systems. This suggests that AI adoption in TVET is still at an early and unstructured stage. The limited access to formal training where nearly half of the respondents reported no training further highlights a significant institutional capacity gap that may hinder effective and ethical AI integration. We conducted a total of three interviews with teachers and administrators regarding lack of AI training, low digital literacy levels and a lack of support for the integration of artificial intelligence (AI). From the literature on the adoption of AI in TVET education in developing countries it appears that human capacity barriers such as digital skills and professional training are a major barrier to the effective use of technology. This combined with the results of our survey, qualitative findings and the literature suggests that human capacity

is one obstacle to implementing AI into TVET education. Overall, respondents indicated that they are somewhat familiar with and experienced with AI tools, but lack the advanced knowledge, conceptual knowledge, ethics awareness and training in using AI. Without contextualized and regular capacity-building programs the continued mainstreaming of AI in TVET institutions is unlikely to be successful.

Table 4.5: Frequency Analysis of Stakeholder Engagement

Stakeholder Engagement (FMC2)			
Question	Response	Count	%
Q9. AI can improve teaching & learning			
	Yes	59	88.1%
	No	5	7.5%
	Somehow	3	4.5%
Q10. AI helps students learn effectively			
	Yes	57	85.1%
	No	6	9.0%
	Somehow	4	6.0%
Q11. AI should be in the TVET curriculum			
	Yes	53	79.1%
	No	8	11.9%
	Somehow	6	9.0%
Q12. Willing to learn and use AI tools			
	Yes	60	89.6%
	No	4	6.0%
	Somehow	3	4.5%
Q13. Have you ever used AI tools for sharing educational materials or collaborative work?			
	a. Yes	57	85.1%
	b. No	10	14.9%
Q14. Does your institution follow any standards or frameworks for AI integration?			
	Yes	0	0%

	No	8	25%
Q15. Use AI-powered communication tools			
	Yes	51	76.1%
	No	16	23.9%

FMC2 measures respondents' perceptions, willingness and levels of engagement regarding the introduction of AI into TVET education. There is a high level of positive perception of AI with 88.1% of respondents agreeing that AI can improve teaching and learning 7.5% disagreed and 4.5% were partial agreement. 85.1% of respondents agreed that AI helps students learn effectively while 9.0% disagreed and 6.0% were unconvinced. There is a strong sense of support for the inclusion of AI in TVET curriculum with 79.1% supporting the inclusion of AI in TVET curriculum as opposed to 11.9% of respondents and 9.0% being undecided. 89.6% of respondents indicated they were willing to learn and use AI tools 6.0% indicated no willingness and 4.5% were uncertain. In terms of practical applications 85.1% of respondents said they have used AI to share educational materials or collaborate and 14.9% did not. The same percentage (76.1%) mentioned using AI-based communication tools and 23.9% did not. But, when asked if the respondents knew of any institutional standards or frameworks incorporating AI none of the respondents (0.0%) said yes or did not know.

The positive nature of these descriptive outcomes suggests that stakeholders are positive about the role of AI in teaching and learning and strongly inclined to use AI tools. In addition, there were high levels of agreement on each of the items which suggests that respondents generally believe that AI is beneficial for improving educational processes. On top of that there was a high level of willingness to learn and use AI tools which suggests that respondents are willing to try out AI technologies. Even if these findings were highly positive the individual was actively involved. But, there were no institutional arrangements or standards indicating that stakeholders are not ready for or willing to give support. According to our findings AI use was mainly driven by individuals rather than a coordinated strategy in the institution which may hinder the consistency, effectiveness and viability of integration of AI in TVET.

Triangulation of the data also revealed the participants mentioned the lack of formal policies, guidelines and direction with regards to incorporating AI. In addition, the literature on the adoption of technology in education makes the case that if there is a lack of governance or institutional alignment it can be difficult to make change happen. With the findings of the survey, interviews and writings the emergence of these themes indicates that engagement of stakeholders is not enough without the support of appropriate structures. Overall, findings of Stakeholder Engagement (FMC2) indicate that stakeholders appear very supportive, motivated and involved in the use of AI. There are no formal institutional frameworks that may encourage this kind of involvement as it occurs between individuals rather than through organizations. Clearly, there needs to be better alignment and institutional support to translate this sense of readiness into effective and sustainable use of AI in TVET education.

Table 4.6: Frequency Analysis AI Institutional Readiness

Institutional Readiness (FMC3)			
Question	Response	Count	%
Q16. Current curriculum includes AI/digital content			
	Yes	18	26.9%
	No	37	55.2%
	Somehow	12	17.9%
Q17. College is prepared to integrate AI			
	Yes	19	28.4%
	No	14	20.9%
	Somehow	34	50.7%
Q18. Institutional support for digital transformation			
	Yes	19	26.3%
	No	35	48.6%
	Somehow	13	25.0%
Q19. Enough guidelines/policies for AI			
	Yes	0	0%
	No	4	100%

	Somehow	0	0%
Q20. How often does AI training occur?			
	Once a year	43	64.2%
	Once a semester	15	22.4%
	Never	9	13.4%
Q21. Enough computers for digital learning			
	Yes	46	68.7%
	No	16	23.9%
	Somehow	5	7.5%
Q22. Internet supports AI based tools			
	Yes	49	73.1%
	No	13	19.4%
	Somehow	5	7.5%
Q23. Adequate digital learning resources			
	Yes	15	22.4%
	No	44	65.7%
	Somehow	8	11.9%
Q24. ICT support staff are available			
	Yes	31	46.3%
	No	27	40.3%
	Somehow	9	13.4%

Institutional Readiness (FMC3) questions addressed respondents' views on curriculum and AI integration into TVET education, institutional support, governance, training and infrastructural capacity for AI integration. Among respondents who indicated that the curriculum already had AI or digital content 26.9% indicated that the curriculum was already inclusive of AI or digital content, while 55.2% indicated that the curriculum does not have AI or digital content or that it is partially included. About overall institutional readiness to integrate AI 28.4% perceived their institution as prepared 20.9% perceived the institution as not prepared and 50.7% perceived as

partially prepared. 26.3% of respondents thought that there is enough institutional support for digital transformation whereas 48.6% perceived the support as lacking and 25.0% perceived support as partial. None of the respondents (0%) said they had policies or guidelines to help them introduce AI and all respondents indicated they did not have any such policies or guidelines. Regarding training practices 64.2% said they offer AI training once a year 22.4% say once a semester and 13.4% don't offer any training at all. 68.7% of respondents said they have enough computers for digital learning, whereas 23.9% said computers were not readily available and 7.5% said they were partially available. 73.1% said they have internet access that supports AI tools while 19.4% disagreed and 7.5% said they do not. Only 22.4% of respondents confirmed that there is adequate digital learning resources available, 65.7% indicated it was not available and 11.9% indicated partial support is available. These results are very much in line with qualitative interview data. Interviewees mentioned again and again that a clear strategic direction and policy frameworks are lacking. For instance, one participant pointed out that "the institution lacks clear policy or guideline that promotes AI integration." Another interviewee stated, "There are no organized training programs for AI most employees either learn on their own or not at all." These quotations confirm the survey outcome that institutions are still very much unprepared.

These descriptive findings suggest uneven and limited institutional readiness for AI integration. Most respondents rated their institutions' infrastructure as being available on a basic level including a computer and internet access but there was not enough digital learning content, suggesting that infrastructure is not fully ready to help integration of AI. Respondents who rated their institution as partially prepared or only partially supported suggest an infrastructural gap in which institutions are not yet fully prepared to implement AI. The absence of any policy or guideline for AI integration suggests that there is no way to steer and coordinate AI activities which may be unsuitable for long-term implementation. On top of that the lack of training programs indicates insufficient capacity-building efforts which may impede stakeholders' access to AI in education. On top of that qualitative interview data supports the findings from the study where respondents mentioned the lack of a strategic plan, the lack of AI policies. Other literature about digital transformation in education indicates that institutional readiness for AI integration also requires governance, policy and training. Across our three segments of data the findings

from the survey and interviews indicate that institutional readiness is a major obstacle to the implementation of AI in TVET education. In general, these results suggest that although some institutional infrastructure exists, there is still a lot of room for improvement on curriculum, governance, training and digital content. It suggests that without comprehensive changes in the institutions themselves such as policy and capacity building AI will not be effective and sustainable in TVET institutions.

Table 4.7: Frequency Analysis of Data Governance & Ethical standard

Data Management & Governance, Ethical, Legal & Policy Framework (FMC4), (FMC5)			
Question	Response	Count	%
Q25. What would you do if you noticed suspicious activity in an AI system?			
	Ignore it	4	6.0%
	Report to department head	18	26.9%
	Report to IT security team	34	50.7%
	Not sure who to report	11	16.4%
Q26. Which statement about AI tool security is most accurate?			
	a. Using free AI tools is always safe for educational purposes	5	7.5%
	b. Institution-approved AI tools eliminate all security risks	9	13.4%
	c. All AI tools have similar security and privacy protections	7	10.4%
	d. Regular security reviews and cautious usage are necessary for all AI tools	46	68.7%
Q27. Are AI communication tools secured with encryption?			
	Yes	19	28.4%
	No	27	40.3%
	I don't know	21	31.3%
Q28. Which security measures do you apply when using AI tools?			

	Use strong, unique passwords	30	44.8%
	Avoid sharing confidential data	8	11.9%
	Keep AI software updated	12	17.9%
	Monitor account activity	5	7.5%
	Regularly review chat history	3	4.5%
	Use two factor authentication	9	13.4%
	Verify privacy policies	5	7.5%
Q29. How do you secure your AI tool accounts?			
	Strong passwords for personal accounts	46.3%	46.3%
	Two factor authentication for both	40.3%	40.3%
	Use same password across tools	7.5%	7.5%
	Rarely change passwords	6.0%	6.0%
Q30. Who is primarily responsible for AI ethics and security in education?			
	a. AI tool developers and companies	31	46.3%
	b. Individual users (teachers and students)	29	43.3%
	c. Institutional leadership and administration	6	9.0%
	d. Government regulatory bodies	1	1.5%
Q31. What would you do if an AI tool asked for sensitive institutional data?			
	Provide the data	9	13.4%
	Share if colleagues do	11	16.4%
	Consult IT department first	37	55.2%

	Not sure what to do	10	14.9%
Q32. Which risks concern you most when using AI tools for education?			
	a. Copyright violation through AI generated content	6	9.0%
	b. AI tools may include biased or inaccurate information	58	86.6%
	c. Privacy risks from sharing data with AI systems	3	4.5%

Data Management & Governance and Ethical, Legal & Policy Framework (FMC4 & FMC5) reported responses regarding respondents' knowledge and practices about AI security data protection and ethical responsibility in education. Those asked for their responses to suspicious behavior with AI systems 50.7% indicated they would report it to the IT security team, 26.9% to the department head 16.4% were unsure who to report it to and 6.0% chose not to report anything at all. In terms of their knowledge about the security of AI tools 68.7% of respondents correctly responded that regular security reviews and careful use are necessary while fewer incorrect responses were selected such as saying that free AI tools are always safe (7.5%), that only tools approved by the institution are safe (13.4%) or that all AI tools have similar security features (10.1%).

In terms of technical security awareness 28.4% reported that AI communication tools were encrypted while 40.3% said they are not encrypted and 31.3% said they do not know. When asked about security practices 44.8% of respondents indicated they used strong, unique passwords, 17.9% said they kept their software current and 13.4% said they used two-factor authentication. Other security practices such as not sharing private information (11.9%) monitoring account activity (7.5%) reading privacy policies (7.5%) or reviewing chat history (4.5%) were less frequent. Similarly, when asked how security practices were related to accounts 46.3% of respondents reported using strong passwords and 40.3% reported they used two-factor authentication, with a smaller proportion of respondents indicating weaker practices such as reusing passwords (7.5%) or rarely changing them (6.0%). Concerning responsibility for AI ethics and security 46.3% of respondents stated they were responsible for AI developers and

companies while 43.3% of respondents were responsible for the AI's users. Only 9.0% and 1.5% of respondents cited school leaders and government regulators as responsible. And when asked what they would do if AI tools requested sensitive data from their institutions 55.2% said they would contact the IT department 16.4% would follow their colleagues, 13.4% would provide the data and 14.9% were unsure. Concerning perceived risks most respondents (86.6%) cited misinformation as the greatest concern, followed by copyright issues (9.0%) and privacy concerns (4.5%). These data reflect respondents' moderate awareness of AI security practices and ethics. The high proportion of respondents who correctly identified the need to use AI in a cautious manner and to report suspicious activities to the appropriate channels suggests some awareness of AI security practices. The uncertainty surrounding topics such as encryption, reporting or who is responsible for AI governance indicates a lack of understanding or procedural clarity on those topics. The variety in security practices indicates that while some respondents follow guidelines these strategies are not always followed by all users.

As far as responsibilities for AI ethics and security are concerned there is insufficient institutionalization. The majority of respondents seemed to place more responsibility on external people (developers, customers) or users (people who know better) which suggests that the nature of institutional governance for AI is not well understood. In addition, most respondents showed caution when handling sensitive data but a significant proportion of respondents were willing to share data or uncertain what to do. These findings are reinforced by a triangulation of data from qualitative interviews where participants commented on lack of formal data governance processes, knowledge of institutional policies and lack of education on AI ethics and cybersecurity. Further research on the use of AI in education suggests that effective use of AI involves not only awareness but also institutional policies compliance with regulations and data protection mechanisms. The combined data from the survey, interviews and literature indicate that awareness is occurring, but institutions lack the proper governance and policy processes.

Overall, FMC4 and FMC5 results indicate that stakeholders are of basic to moderate awareness regarding AI security and ethical issues. But, information on technical aspects, procedure and governance are incomplete. For the use of AI in TVET education there needs to be a framework for data management, guidelines on ethics, training and institutional responsibilities.

Table 4.8: Frequency Analysis of Demographic Features for AI Integration Study

Question	Option	Frequency	Percent
Q1. Gender			
	Male	45	67.2%
	Female	22	32.8%
Q2. Age Group			
	≤ 20	16	23.9%
	21-30	32	47.8%
	31-40	14	20.9%
	41-50	5	7.5%
Q3. Department			
	ICT	25	37.3%
	Electrical & Electronics	12	17.9%
	Automotive	9	13.4%
	Garment & Textile	10	14.9%
	Manufacturing	8	11.9%
	Other	3	4.5%
Q4. Role			
	Student	35	52.2%
	Teacher	17	25.4%
	Department Head	11	16.4%
	Staff(Admin)	4	6.0%
Q5. Years of Experience			
	Still trainees	35	52.2%
	3-5	12	17.9%
	6-10	11	16.4%
	11+	9	13.4%

The demographic data above serve three purposes: first, it ensures that the purposive sample is representative of the roles and responsibilities for curriculum development and AI-integration decision-making in the institution (students in Levels 3 and 4, instructors, department leadership, senior and junior staff, and administrative officers). Second, it allows the reader to consider whether the sample is balanced enough to avoid obvious selection bias, particularly is it representative of a specific role, gender or level of education. Third, demographic variables control how the responses to the parts of the framework reported in chapter are taken into account if response patterns differ across roles or by level, this is noted in the narrative so that recommendations to be tailored rather than generalized. Demographics were not only used to provide an overview of the respondents, but also to gain an understanding of the responses and experiences related to AI integration. Gender, age, department, role and experience were important to understand in order to better assess the perceived awareness, readiness and interest of the participants regarding AI in TVET education. Demographic data served as a basis to interpret responses by stakeholder groups in the later sections of this chapter.

A demographic survey of respondents provided an overview of the gender composition of the participants of the study. 67.2% of respondents were male and 32.8% were female. Of the respondents aged between 21- 30, 47.8% of the respondents were between 21 and 30, followed by 23.9% of respondents aged 20 or below, 20.9% of respondents aged 31-40, 7.5% of respondents aged 41-50. 37.3% of the respondents were from the ICT department, 17.9% from Electrical and Electronics, 14.9% from Garment and Textile, 13.4% from Automotive, 11.9% from Manufacturing and 4.5% from other departments. In terms of roles students were the most frequent respondents with 52.2% of the survey followed by teachers (25.4%), department heads (16.4%) and administrative staff (6%). Of respondents still trainees, 17.9% of the respondents had 3–5 years-experience 16.4% had 6–10 years and 13.4% had more than 11 years of experience. These results indicate that most respondents were male, and more than half were young adults (21–30 years old). Since many of the respondents were students and trainees this means that these results reflect the views of those who are learning rather than those of people with a lot of experience. Similarly, the proportion of respondents from the ICT department may indicate that the respondents were more familiar with digital technology than those from other

departments. This may impact the perception of AI in general as those with an ICT background are more likely to be familiar with digital tools and new technologies.

The participation in the survey was representative of a range of roles and departments suggesting that the results may reflect the perspectives of the learner more than those of the institution or administrative staff. This means the results give us a glimpse into what the stakeholders mainly the learners think but one should be careful when extending these results to all levels of the institution. The demographic profile essentially paints a picture of the study being based on the perceptions of young student-heavy and moderately tech-savvy individuals which certainly is a good angle for the topic of AI integration perceptions in TVET education. However, to have a full view of the institution it may need adding the views of more experienced stakeholders.

Table 4.9: Frequency Analysis for Technological Infrastructure

Technological Infrastructure (FMC6)				
No	Question	Response	Count	Percent (%)
1	Does your institution have stable internet access?	Yes	60	89.6%
		No	7	10.4%
2	Does your institution provide sufficient computers/laptops?	Yes	63	94.0%
		No	4	6.0%
3	Does your institution have functional computer laboratories?	Yes	63	94.0%
		No	4	6.0%
4	Does your institution have servers or cloud support for AI systems?	Yes	47	70.1%
		No	20	29.9%
5	Is network equipment available and functioning properly?	Yes	55	82.1%
		No	12	17.9%
6	Does your institution provide licensed/updated software?	Yes	41	61.2%
		No	26	38.8%
7	Is technical support staff available for ICT maintenance?	Yes	63	94.0%
		No	4	6.0%

8	Does your institution have backup power support (UPS/Generator)?	Yes	57	85.1%
		No	10	14.9%
9	Is internet speed adequate for AI-based activities?	Yes	55	82.1%
		No	12	17.9%
10	Are ICT facilities regularly maintained and upgraded?	Yes	47	70.1%
		No	20	29.9%

Technological Infrastructure (FMC6), on respondents' perception of the availability and suitability of ICT resources to support AI integration in TVET institutions, revealed that 89.6% of respondents said they have stable internet access while 10.4% indicated that they are experiencing instability. 94.0% of respondents said they have enough computers or laptops available and a comparable proportion of respondents confirmed that they have working computer laboratories. In terms of advanced infrastructure 70.1% of respondents said they have servers or cloud support for AI systems but 29.9% said they do not. In terms of network infrastructure 82.1% of respondents indicated that network equipment is available and working while 17.9% reported difficulties. Another 61.2% of respondents reported receiving licensed and updated software while 38.8% stated that they did not have such provision. Lastly, 94.0% of respondents confirmed they had technical support staff for ICT while 6.0% denied having such support. 85.1% also confirmed they had backup power such as UPS or generators while 14.9% said they did not have such power. In terms of internet speed 82.1% of respondents said they thought the internet speed was adequate for AI based activity while 17.9% disagreed. Finally, 70.1% of respondents said they are regularly maintaining and upgrading their ICT equipment while 29.9% said they were not regularly maintaining them.

These descriptive findings indicate that these institutions have a relatively solid basic ICT infrastructure particularly in terms of connectivity, hardware availability and technical support. There are several computers, laboratories and internet access at each institution all of which reflect the essential elements for digital learning. But, there are not many servers or cloud support or licensed software indicating that advanced AI implementation may still be inaccessible. As reported in the survey there was variation in responses regarding software provision, infrastructure maintenance and advanced computing resources indicating that basic infrastructure

is in place but may not have been well adapted for more complex AI-related applications. It also suggests that schools may be better prepared for basic or entry-level use of AI than for large scale or advanced integration of AI. Similarly, the lack of maintenance and software licensing may affect the sustainability and reliability of AI-supported education.

With the help of qualitative interviews participants indicated that they faced difficulties in accessing advanced ICT equipment, software or maintaining systems regularly. Based on the literature on adoption of AI in education, it appears that while the basic infrastructure is important, to integrate AI effectively users should have access to high-end computing resources, software solutions and constantly upgrade the infrastructure. Our survey results, interviews and literature suggest that the infrastructure is in place but need investment and development to accommodate advanced and sustainable AI. Overall, the outcomes for Technological Infrastructure (FMC6) indicate that institutions have established a foundation of ICT resources including connectivity, hardware and technical support but a lack of advanced ICT infrastructure, software provision and maintenance may need to be improved for the adoption of AI in TVET education.

Table 4.10: Frequency Analysis of Curriculum and Pedagogical Integration

Curriculum and Pedagogical Integration (FMC7)			
Question	Response	Count	Percent (%)
Q1. To what extent is AI content integrated into the existing TVET curriculum?			
	Not Integrated	67	100%
	Slightly Integrated	0	0%
	Moderately Integrated	0	0%
	Highly Integrated	0	0%
	Fully Integrated	0	0%
Q2. How frequently are AI tools used to support teaching and instructional delivery?			
	Never	4	6.0%
	Rarely	9	13.4%

	Occasionally	11	16.4%
	Frequently	43	64.2%
Q3. To what extent does AI support adaptive learning and personalized instruction for students?			
	Not at all	5	7.5%
	To small extent	8	11.9%
	To moderate extent	10	14.9%
	To a great extent	6	9.0%
	To a very great extent	38	56.7%
Q4. How well are instructors prepared to integrate AI into their pedagogical practices?			
	Not Prepared	6	9.0%
	Slightly Prepared	9	13.4%
	Moderately Prepared	10	14.9%
	Well Prepared	42	62.7%
Q5. To what extent does the curriculum include practical AI-related competencies aligned with industry needs?			
	Not at all	67	100%
	To small extent	0	0%
	To moderate extent	0	0%
	To a great extent	0	0%
	To a very great extent	0	0%

Curriculum and Pedagogical Integration (FMC7) asked what extent AI is embedded in curriculum content and teaching practices in TVET institutions. 100% of respondents indicated that AI was not taught as part of the existing curriculum, with no respondents indicating a partial or full integration. In terms of instructional practices 64.2% of respondents reported that AI tools are often used to support teaching, 16.4% said they were occasionally using AI tools, 13.4% said they were rare and 6.0% said they never use AI tools. With respect to adaptive learning and personalized instruction, 56.7% of respondents indicated that AI supports learning to a very great extent, 14.9% moderate support 11.9% small extent 9.0% great extent and 7.5% said no support.

A total of 62.7% of respondents reported they are prepared to implement AI in their teaching practices with 14.9% indicating moderate preparation 13.4% indicating slight preparation, and 9.0% stating they are not prepared. The majority of respondents still indicated the curriculum does not address the needs of industry in terms of skills relevant to AI, with none responding that the curriculum does.

Observation of differences between the design of the curriculum and practice indicate a distinction in the design of the curriculum. Though AI is not officially integrated into the curriculum, numerous applications of AI tools are used in the classroom, suggesting that instructors and students are formally incorporating AI into their teaching practices. The study evidences that this is happening at the practice level, not within the framework of the curriculum. The high number of respondents strongly supportive of adaptive learning suggests that using AI in the classroom may enhance the personalized learning experiences for the student. With regards to the lack of AI content and industry-related competencies within the curriculum, it is clear that the practice of education does not match the curriculum. This means that although the instructors are using AI tools independently, they do not integrate them into their teaching or job descriptions. On top of that most respondents thought the instructors were well prepared but this may reflect a perception of basic or informal skill than formal training in how to integrate AI into their teaching. Triangulation with qualitative interview data supported these results where participants expressed that the use of AI in their teaching was not directed by a curriculum or institutional policy. A literature review of the integration of AI in education suggests that it is necessary for effective incorporation to occur that there is alignment between curriculum, educational practice and industry needs. Without this alignment no schools will be able to deliver structured and competency-based AI education. Overall, for Curriculum and Pedagogical Integration (FMC7) though AI tools are used in the classroom and their use is perceived to aid in learning the integration with these tools is informally integrated into the curriculum. Given this lack of integration and skills aligned with industry demands, curriculum needs to be reviewed pedagogy must be developed and the skills needed to assist in the successful integration of AI in TVET training should be aligned with labour market needs.

Table 4.11: Frequency Analysis of Sustainability and scalability

Sustainability and scalability (FMC8)			
Question	Response	Count	Percent (%)
Q1. To what extent does your institution have a long-term strategic plan for AI integration?			
	No plan	15	22.4%
	Very limited plan	18	26.9%
	Moderately Developed plan	16	23.9%
	Well-Developed plan	11	16.4%
	Comprehensive and Sustainable Plan	7	10.4%
Q2. How adequate is the financial support allocated for sustaining AI initiatives?			
	Very Inadequate	21	31.3%
	Inadequate	19	28.4%
	Moderately Adequate	17	25.4%
	Adequate	10	14.9%
Q3. How frequently are AI tools updated and improved based on technological advancements?			
	Never	13	19.4%
	Rarely	21	31.3%
	Occasionally	19	28.4%
	Frequently	14	20.9%
Q4. To what extent does your institution provide continuous professional development related to AI?			
	Not at all	10	14.9%
	To small extent	18	26.9%
	To moderate extent	21	31.3%
	To a great extent	13	19.4%
	To a very great extent	5	7.5%

Q5. How effectively does your institution use monitoring and evaluation results to continuously improve AI implementation?			
	Not Effective	13	19.4%
	Slightly Effective	17	25.4%
	Moderately Effective	19	28.4%
	Highly Effective	12	17.9%
	Extremely Effective	6	9.0%

Survey results on Sustainability and Scalability (FMC8) address respondents' views on long-term planning, financial support, system improvement, professional development and monitoring for the AI integration in TVET institutions. 22.4% of respondents said their institution had no plan for AI integration 26.9% said they had a very limited plan 23.9% said they had a moderately developed plan. Only 16.4% of respondents reported having well-developed plans and 10.4% stated they had comprehensive plans. On financial support 31.3% of respondents rated it as very inadequate 28.4% as inadequate 25.4% rated it moderately adequate and only 14.9% of respondents rated it as adequate. 31.3% of respondent's rated AI tools as rarely updated while 28.4% reported occasional updates 20.9% said they receive frequent updates and 19.4% reported there are no updates at all. In terms of training for professional growth 31.3% of respondents said that training is provided moderately 26.9% said it is very little and 14.9% said there is none at all. 19.4% and 7.5% of respondents said training is provided very highly and very highly, respectively. Monitoring and evaluation was rated as moderately effective by 28.4% of respondents 25.4% reported it was somewhat effective and 19.4% said it is not effective by 19.4%. In addition, 17.9% and 9.0% responded to monitoring and evaluation as high or extremely effective respectively.

These descriptive findings suggest that AI integration has only started to prove viable and scalable. The distribution of responses on strategic planning suggests that while some institutions have begun to plan, many do not have well-articulated and well-articulated strategies over the long term. The proportion of respondents reporting inadequate financial support indicated an issue that may hinder continued and expanded AI efforts. The irregularity in the updates and professional development also indicates that continuous improvement is not always practiced.

This means that schools may have difficulty in keeping up to date with AI systems and making sure that their staff continue to learn to deal with new technological advances. Finally, the moderate effectiveness of monitoring and evaluation means that if they exist, they are not utilized as much as possible for continuous improvement and decision-making. These findings are also supported by the qualitative interview data on budget, direction and focus on continuing capacity building for AI integration. In addition, in the literature on sustainable technology integration, it was noted that long-term success depends on planning, funding, continuous system updates and monitoring. Survey results, interview findings and the literature document that sustainability and scalability are still challenges to AI implementation in TVET education. Overall, the results from FMC8 show that while there are early steps towards AI integration there remain gaps in planning, continuous improvement and monitoring. These issues suggest that long-term planning, budgeting, training and evaluation are required to ensure the sustainability of AI integration in TVET.

Table 4.12: Technical Challenges in AI Integration Framework (Open-response question)

Items	Yes	No	Total
Do you have any certified training on AI tools and platforms?	57	10	67
Percent (%)	85.1%	14.9%	100%
Do you have any formal training on AI Ethics (algorithmic bias, fairness, transparency and accountability)?	12	55	67
Percent (%)	17.9%	82.1%	100%
Have you received any formal training in AI security (including encryption and access controls)?	9	58	67
Percent (%)	13.4%	86.6%	100%
Does the college have AI integration Strategy and policy?	11	56	67
Percent (%)	16.4%	83.6%	100%

Training of staff and AI strategy measures the respondents' exposure to or lack of formal training regarding AI tools and platforms with 14.9% not having any. For the training of AI ethics only 17.9% of respondents indicated they had been trained and the majority (82.1%) stated they had not been exposed. For security training in AI (encryption and access control) only 13.4% of

respondents indicated they had been trained and 86.6% said they had not. As for readiness 16.4% of respondents indicated that their institution had a strategy or policy for integration of AI, while 83.6% reported having none. The descriptive results showed a gap between general exposure to AI tools and formal training in areas of ethics and security. While most respondents had some form of training in AI tools, the lower percentages of respondents who had ethics and security training suggested this was not adequately addressed in the current capacity-building efforts. This may prevent staff from using AI responsibly and securely in education settings where ethical considerations and data protection are of great importance.

In addition, there are no formal institutional strategies or policies for AI integration which suggests that the adoption of AI is occurring without a coordinated approach thus leading to uniform practices, limited accountability and potentially unsafe usage of AI. As mentioned above, we conclude that while there is some degree of technical exposure, institutional readiness in terms of governance and implementation is limited. Such results are further supported by three-way triangulation of the interview data where participants said they did not have access to training in AI ethics and security or policies on AI integration. Plus, the literature on adoption of AI in schools suggests that effective implementation requires not only technical training but also ethical, security and governance training. Overall, the survey data, interviews and literature points indicate that gaps in training and policy are troubling issues. Overall, the results reveal that while the respondents reported fairly high levels of exposure to AI tools there are gaps in formal training in ethics and security as well as institutional strategy and policy formulation. Filling these gaps through training and development of clear AI governance regimes is critical to having responsible, safe and effective integration of AI into TVET education.

Table 4.13: Strategic and Implementations on AI Integration Framework

Items	Measurement					Total
	Strong agree	Agree	Neutral	Disagree	Strong disagree	
AI integration is more effective than traditional teaching methods	22	25	16	4	0	67

Percent (%)	32.8%	37.3%	23.9%	6.0%	0%	100%
2. Using AI improves learning outcomes in TVET education	20	30	16	1	0	67
Percent (%)	29.9%	44.8%	23.9%	1.5%	0%	100%
3. AI contributes to improved use of educational data for decision-making	20	30	11	6	0	67
Percent (%)	29.9%	44.8%	16.4%	9.0%	0%	100%
4. AI is perceived to increase students' access to educational resources	18	23	16	9	1	67
Percent (%)	26.9%	34.3%	23.9%	13.4%	1.5%	100%
5. AI is perceived to improve teaching efficiency in TVET colleges	15	36	8	8	0	67
Percent (%)	22.4%	53.7%	11.9%	11.9%	0%	100%
6. Respondents are uncertain whether AI has led to major success in curriculum delivery	2	21	29	15	0	67
Percent (%)	3.0%	31.3%	43.3%	22.4%	0%	100%
7. AI is perceived to support tracking of student learning progress	10	27	21	5	4	67
Percent (%)	14.9%	40.3%	31.3%	7.5%	6.0%	100%
8. AI is perceived to reduce wastage of educational resources	16	36	12	3	0	67
Percent (%)	23.9%	53.7%	17.9%	4.5%	0%	100%
9. AI is perceived to shorten time for assessment and feedback	18	30	16	3	0	67
Percent (%)	26.9%	44.8%	23.9%	4.5%	0%	100%
10. AI is perceived to improve efficient use of teaching resources	13	35	16	3	0	67
Percent (%)	19.4%	52.2%	23.9%	4.5%	0%	100%

Such results are further supported by three-way triangulation of the interview data, where participants said they did not have access to training in AI ethics and security or policies on AI integration. Plus, the literature on adoption of AI in schools suggests that effective implementation requires not only technical training but also ethical, security and governance training. Overall, the survey data, interviews and literature points indicate that gaps in training and policy are troubling issues. Overall, the results reveal that while the respondents reported fairly high levels of exposure to AI tools, there are gaps in formal training in ethics and security as well as institutional strategy and policy formulation. Filling these gaps through training and development of clear AI governance regimes is critical to having responsible, safe and effective integration of AI into TVET education. These descriptive outcomes suggest that respondents have generally positive views about the role of AI in improving teaching, learning, and resource management. The high percentage of agreement across items suggests that AI is viewed as a tool for improving various aspects of education. The number of neutral responses (particularly to questions regarding educational success in curriculum delivery) suggests some ambiguity about the overall impact of AI on the educational system. A collocation of positive perceptions at the instruction level and uncertainty at the institution level suggests that AI may currently be present in individual teaching and learning rather than transformation within the institutions. This suggests that although AI may be useful in a few areas such as assessment, resource management and learning support its integration into the institutions' system or curriculum may be limited or early.

Triangulation with qualitative interview data indicates that the participant stated that they use AI tools frequently at home, but not as a part of the overall curriculum. As noted by the research literature on AI in education positivity alone is not enough to provide measurable institutional impact without implementing, supporting policies and implementing infrastructure. Given the combination of the survey data, the interview data and the published research, results from the current study support the notion that the perceived benefits of AI are greater than the actual benefits. Overall, the overall perception was that AI could enhance teaching, learning and resource management in TVET education. The narrow consensus on the extent to which AI integration was successful at an institutional level suggests that the implementation of AI is still in its infancy and has yet to be seen.

4.4. Qualitative Data Analysis and Interpretation

4.4.1. Thematic Analysis

The qualitative interview data was analyzed using Thematic Analysis in order to identify themes, meanings and conclusions on the role of AI in AATPC and organize these responses into meaningful themes. Data were presented to interviewees for familiarization with the data, coding, the development of themes and review and refinement of these themes. Based on this process eight key thematic categories emerged from the data such as training gap, institutional barriers, positive impact, AI usage, future needs, psychological barriers, infrastructure issues and AI awareness.

4.4.2. Coding Process

The process of coding consisted of assigning a concise label to selected segments of the interviews. I first read each response and then selected some words or phrases to represent the meaning. I grouped responses such as “lack of training” and “no formal AI skills” under training gap and “absence of policies” and “lack of institutional support” under institutional barriers. I grouped expressions such as “fear of AI replacing teachers” under psychological barriers and “using AI tools for assignments” under AI usage. I then reorganized the initial codes into categories for consistency, clarity and increased analytical rigor.

4.4.3. Code Frequency Analysis

A frequency analysis was conducted to determine how often each code appeared across the dataset. The result presented in the bar chart provide a quantitative perspective on the prominence of each theme. The findings indicate that the training gap is the most frequently occurring issue, highlighting a critical lack of knowledge and skills required for AI integration. This is followed by institutional barriers which reflect structural challenges such as the absence of policies, limited administrative support and lack of strategic direction. Notably, the theme of positive impact also recorded a high frequency suggesting that respondents recognize the potential of AI to enhance teaching and learning processes. This indicates a generally favorable attitude toward AI despite existing challenges.

Themes such as AI usage and future needs show moderate frequencies indicating that while AI tools are being used informally often through platforms like ChatGPT there is a strong demand for structured implementation and further development. Lower-frequency themes including psychological barriers, infrastructure issues and AI awareness reveal additional constraints. Psychological resistance driven by fear, low confidence and inadequate infrastructure further limit effective adoption. Meanwhile, limited awareness suggests that exposure to AI remains largely informal and unstructured. Overall, the frequency analysis demonstrates that AI integration in TVET colleges is influenced by a combination of skill-related, institutional, technical and psychological factors.

4.5. Themes Interpretation

The themes identified from the analysis provide a comprehensive understanding of the current state of AI integration in TVET colleges.

4.5.1. Training Gap

The prominence of this theme indicates a significant lack of formal training and professional development opportunities. Both educators and students require structured training programs to effectively utilize AI technologies in teaching and learning.

4.5.2. Institutional Barriers

Institutional challenges including the absence of clear policies, guidelines and strategic frameworks, hinder the systematic integration of AI. This reflects a broader issue of organizational unpreparedness.

4.5.3. Positive Impact

Despite the challenges respondents acknowledged the benefits of AI in enhancing learning outcomes, improving teaching efficiency and increasing access to educational resources. This reflects a positive perception of AI's potential.

4.5.4. AI Usage

The findings indicate that AI tools are already being used informally by students and to a lesser extent educators. However, this usage lacks formal structure and academic guidance.

4.5.5. Future Needs

Respondents emphasized the need for capacity-building initiatives, including workshops, training programs and improved institutional support. This highlights a strong expectation for future development.

4.5.6. Psychological Barriers

Fear of job displacement lack of confidence and resistance to change were identified as key psychological barriers affecting AI adoption.

4.5.7. Infrastructure Issues

Although basic ICT facilities are available. But, they are not adequately equipped to support AI-based applications. Limitations include outdated systems and insufficient technical resources.

4.5.8. AI Awareness

The relatively low frequency of this theme suggests that awareness of AI exists but remains limited and largely informal, indicating a need for structured awareness programs.

Qualitative Thematic Analysis Workflow



Figure 4.1: Qualitative Thematic Analysis Workflow

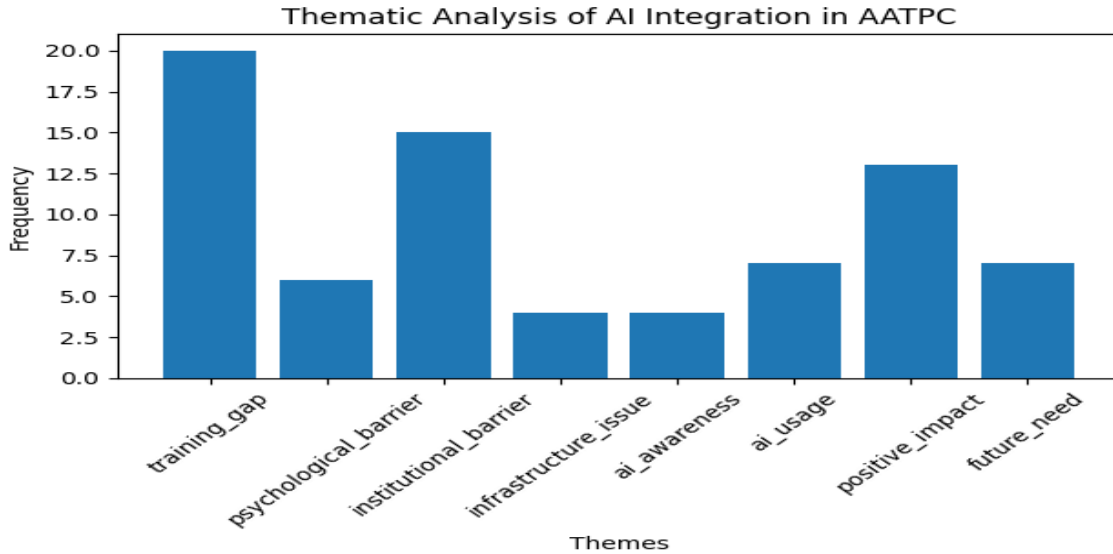


Figure 4.2: Thematic Analysis of AI Integration in AATPC

4.6. Components of the Proposed Framework

The components of the suggested Artificial Intelligence integration framework for AATPC have been shaped by worldwide best practices, including standards of the International Organization for Standardization, literature on AI in education and a TVET institution-based survey. The components have been developed in a way that they complement and support each other. Together, they facilitate the effective, ethical and sustainable integration of AI technologies into both the curriculum and institutional operations. The framework features Curriculum and Pedagogical Integration, Human Capacity (Teacher and Staff Readiness) and Technological Infrastructure as the main components that will aid AI-assisted teaching, learning and assessment processes. Besides that, Institutional Readiness and Stakeholder Engagement are recognized as the fundamental pillars that will ensure leadership commitment and help in the active involvement of students, industry partners and policymakers from the beginning.

Besides that, Data Management and Governance together with an Ethical, Legal and Policy Framework have been incorporated as key components of the framework to ensure compliance with the national data protection and ICT regulations of Ethiopia. These components help in promoting responsible and ethical use of AI within the education system. Lastly, Sustainability and Scalability have been built into the framework to facilitate continuous improvement, accountability and the long-term achievement of AI-enabled TVET programs at AATPC.

Table 4.14: Data-Driven Emergence of AI Integration Framework Components for AATPC

Framework Component	Data Source	Key Insight / Pattern	How Component Emerged	Recommended Actions	Indicators	Responsible Actors
Curriculum & Pedagogy	Survey of instructors & students literature	Lack of AI-integrated content, need for curriculum redesign	AI curriculum integration identified as necessary	Integrate AI modules into TVET curriculum revise teaching strategies to include AI tools	Updated curriculum documents, number of AI-integrated lessons, student engagement level	MOLS, TVET curriculum developers, instructors
Human Capacity (Teacher & Staff Readiness)	Interviews and surveys	Low confidence and limited AI skills among instructors	Training need identified for effective AI adoption	Provide continuous AI training, workshops and certification programs for instructors	Number of trained staff; AI competency assessment scores, training completion rate	TVET institutions, ICT departments, MOLS
Technological Infrastructure	ICT facility assessment	Inadequate ICT infrastructure	Infrastructure gap identified	Upgrade ICT infrastructure (hardware, software,	Internet speed, number of functional	Institutional ICT units, government

	ent; survey	for AI deployment		internet connectivity, AI tools)	ICT labs, availabilit y of AI tools	ICT agencies
Institutiona l Readiness	Adminis trator interviews	Leadership support is critical for AI adoption	Institutiona l governance pillar identified	Establish AI steering committee and strategic AI policy	Existence of AI policy; leadership involvement level, implement ation roadmap presence	College leadership, institutional management boards
Stakeholder Engagement	Interviews with industry partners and policymakers	Multi- stakeholder involvement is essential	Engagement required for sustainability	Develop partnerships with industry and policymakers, establish collaboration forums	Number of partnerships; frequency of stakeholder meetings; collaboration agreements	Industry partners, policymakers, TVET institutions
Data Management &	ISO standards, ICT	Need for secure data	Data protection	Implement data governance	Data breach incidents,	ICT administrators, national

Governance	laws, survey	handling and governance	requirements identified	framework and cybersecurity policies	compliance level, existence of data policy	ICT authority, institutional IT units
Ethical, Legal & Policy Framework	Literature review, ISO standards, survey	AI requires ethical and legal compliance	Ethical framework requirements identified	Develop AI ethics guideline and ensure legal compliance with national ICT laws	Presence of ethics policy, compliance audits; awareness level	MOLS, policymakers, institutional leadership

4.7. The Proposed Framework

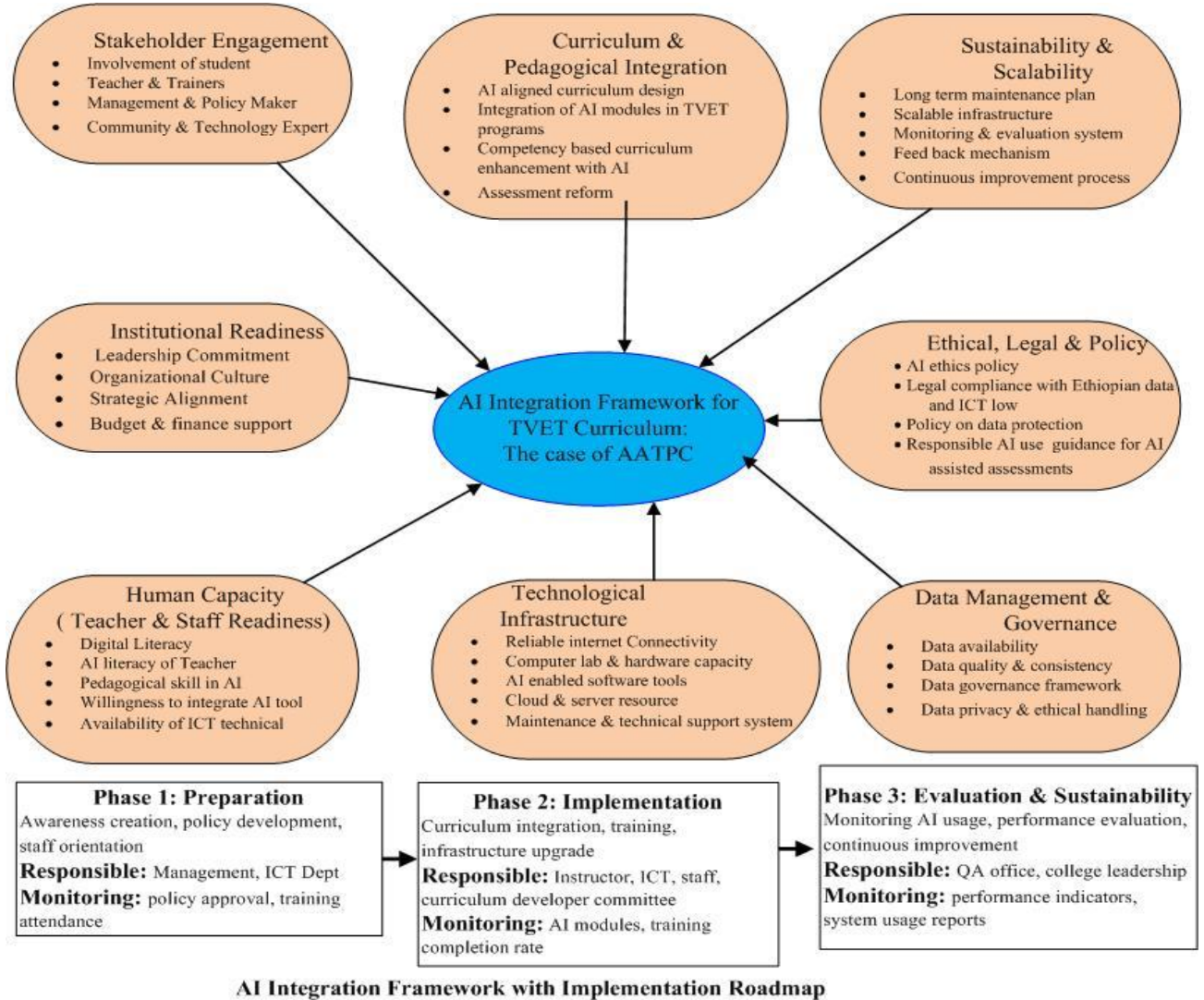


Figure 4.3: AI Integration Framework for TVET Curriculum: The case of AATPC

Descriptions of Proposed Model Architecture

In sum, the AI Integration Framework for TVET Curriculum (AATPC case) is a socio-technical multi-dimensional structure to guide the adoption of Artificial Intelligence in vocational education. Instead of treating AI as a technological upgrade, it is a holistic reformation of the academy that incorporates human, organizational, infrastructure, ethical and pedagogical elements. The heart of the framework is an “AI Integration Framework for TVET Curriculum: The Case of AATPC” that brings all enabling components together in a system. The architecture

is structured around eight factors that promote sustainable and contextually sensitive AI adoption in TVET. The first factor, institutional readiness, is the core of the architecture. It determines the institution's willingness, culture, alignment with strategic goals and financial resources to begin and sustain adoption of AI. Without institutional readiness, other components such as infrastructure development and curriculum reform will not be successful.

The second factor is human capacity: instructor, student and administrative staff readiness. This includes digital literacy, AI literacy, teaching in the context of AI-supported instruction, willingness to adopt new technologies, and availability of ICT-skilled staff. As noted in the second factor, successful AI integration depends much more on people's ability to adapt than on technology. The third dimension (Curricula and Teaching) is to include AI in the teaching and learning process through the incorporation of AI into the curriculum, by integrating AI-related modules in TVET courses by updating the curriculum in a competency-based manner or by changing the ways in which assessment is delivered. AI should become part of the curriculum, not an add-on, with the aim of improving learning and employability. The fourth dimension, technology infrastructure is the technological infrastructure required to enable AI implementation. The technological infrastructure refers to an accessible Internet connection, computer labs, appropriate hardware, AI-enabled software, cloud and server infrastructure and technical support systems that ensure that the physical and digital foundations of AI are present, working, and sustainable. This fifth dimension, data management and governance is concerned with the management of educational data for the ethical handling of that data. It includes data availability, quality, consistency, governance, data privacy and ethical use of data. AI systems heavily rely on data and this fifth dimension is important for ensuring transparency, reliability and accountability in AI-based decision-making in education.

The sixth dimension addresses ethics, legality and policy. It ensures that the inclusion of AI takes place according to ethical principles, institutional policies and national laws, including compliance with ICT and education laws, the formulation of AI ethics guidelines and the formulation of AI usage policies for teaching, learning and assessment. It protects the integrity of the institution and promotes responsible innovation. The seventh dimension, stakeholder engagement, emphasizes collaboration among students, instructors, university administrators,

policy-makers, industry partners and technology experts to share ownership in AI projects and to align them with institutional and labor market needs. Involving AI into the curriculum is important for increasing the acceptability, relevance and sustainability of this technology. The eighth dimension (sustainable and scalability) concerns the long-term viability and expansion of AI integration efforts. This involves planning maintenance, scalability of the systems, monitoring and evaluation, feedback and learning by institutions. This dimension ensures that adopting AI is not only a one-off initiative but is a process.

In preparation of this framework, the goal is to create awareness, policy and staff orientation through the use of the three-phase implementation roadmap. The first phase, implementation, is led by management and ICT departments. The second phase, implementation, involves curriculum development, staff training, and infrastructure development, with teachers, ICT staff, and curriculum committees involved. The third phase, evaluation and sustainability is aimed at monitoring, performance assessment, and improvement led by quality assurance and college leadership. Essentially, the framework is a series of socio-technical components that complement each other. Preparation for the system facilitates the development of infrastructure, training and personnel make the technology work, and curricula enable AI in education, and a sound governance model, ethics and involvement from all stakeholders ensure a responsible implementation. The plan provides a pathway from preparation to adopting technology fully.

4.8. Institutional Readiness

Institutional readiness is one of the core elements for the development of an AI integration framework. It basically defines whether the AATPC has the organizational capacity, a strategic vision and leadership support to implement artificial intelligence in its TVET curriculum or not. In essence, this characteristic involves leadership commitment, institutional policies, organizational culture, strategic alignment and financial preparedness. Committed leadership is a vital element of the whole thing since leaders at the top management level are the ones who have the ultimate power of deciding the directions, allocating resources and promoting institutional changes. In the absence of a framework for policy and decision maker involvement, AI programs may continue to be scattered or only at the pilot stage without having a real impact. Besides, an organizational culture opens to innovation which among other things accepts

technological change and sees changing as a positive factor will have a significant influence on the staff's willingness to adopt AI enabled practices. It is also very important that AI integration goals are in line with the national TVET development strategies, workforce transformation agendas and digital economy goals[54]. Allowance for both current and future expenses is thus very important as AI integration is an investment that has to be supported continuously through infrastructures, training and software licensing and system maintenance. Their studies are always consistent with the statement that technologically advanced education will never fail due to technology limitations but rather due to weak institutional readiness and governance structures[55]. The Institutional Readiness (FMC3) report revealed that TVET institutions are not fully prepared for the adoption of AI in all areas. Only 26.9% of respondents indicated that AI or digital content were included in their curriculum, while most (55.2%) reported that it was missing or partially included. Just over half of respondents perceived their institution as ready, compared to 20.9% who said their institution was unprepared and 50.7% partially prepared. Governance structures are not prepared for digital transformation with 48.6% indicating that their institution is ill-supported and only 26.3% indicating they are prepared. Most respondents (44.2%) said no AI-related policies or guidelines were observed at the institution. There is also no governance structures and none of the respondents (0%) indicating that their institution has adopted any relevant information technology-related policies or guidelines. Training is also slow and irregular with many respondents reporting that they do not train once a year while 13.4% said they had no training at all. While basic infrastructure such as computers (68.7%) and internet connection (73.1%) are accessible digital learning materials (only 22.4%) and ICT support services are inadequate.

4.9. Human Capacity (Teachers & Staff Readiness)

People skills are among the primary elements that determine the success of AI in education. After all, technology alone cannot transform teaching and learning. In fact, the human element here means the change management staff that means teachers, administrative and technical personnel who are willing to adopt, utilize and keep AI-powered educational practices. In addition to customary digital skills teachers also need to have AI literacy that is, knowledge of how AI systems are built, their educational use, drawbacks and ethical aspects. Specifically, pedagogical

proficiency in AI enhanced instruction is vital since educators should be able to use AI tools effectively for designing, delivering and assessing their lessons rather than just superficially employing them[56][57]. Among factors determining the spirit of innovation and technology experimentation the institutional backing the workload and the provision of professional incentives can be named. A well, structured continuous professional development program is the main vehicle for teachers to get equipped and empowered with AI integration skills. Moreover, the presence of ICT technicians guarantees that technologies are working smoothly and that academic staff are not overburdened. Studies about the use of technology in education have been consistent in pointing out that lack of human capacity is the major reason for failure in implementation even in the presence of infrastructure.

Data from FMC1 indicate that respondents are moderately but insufficiently informed about and equipped to use AI. While most (48.8%) reported level of awareness of AI there were still some who said they were only moderately to very familiar with AI (22.4%) low (22.4%) or very low (7.5%) and a few who were very knowledgeable (16.4%) and very knowledgeable (11.9%). Practically speaking 67.2% of the respondents used AI tools such as ChatGPT and 86.1% said they had used them at school, indicating a high level of personal use of AI. Digital skills are also average, with the majority (51.4%) rating their skills as moderate (51.4%) while a significant number of respondents reported low or very low skills (17.8%) and only a minority (25%) rated their digital competence as being competent or highly skilled (25.0%). Conceptual understanding of key AI concepts was low, with only 55.2% correctly understanding machine learning, and only 61.2% of respondents having a lack of the fundamental knowledge required to use AI in a responsible manner. When using AI tools, they are overwhelmingly used for easy to get started with generative applications (76%) while the others are used more sophisticated AI-based learning platforms, adaptive learning tools and AI-based learning management systems (learning). Institutional training was also low with nearly half of respondents reporting that they had no AI training and only 16.4% receiving regular training in AI. These results indicate that although respondents are basic aware of AI and are practicing it and there is a lack of advanced technical skills, conceptual understanding, ethics and formalized professional development that will make it more effective and viable in TVET.

4.10. Curriculum and Pedagogical Integration

The Curriculum and Pedagogical Integration element is the means through which AI is made use of in the core teaching and learning activities. It deals with changes in curriculum, creation of modules and the use of AI powered tools and techniques for educational processes[58]. At AATPC this is an effort that starts with mapping out current curriculum structures and checking their fit with the future labor market trends. The curriculum is made new with the inclusion of AI literacy, data science basics and digital ethics[59]. Pedagogically, AI can be used in adaptive learning systems which tailor the instruction to each student's learning speed and style. Teachers are equipped with skills to use AI driven analytics for formative assessment thus easily following student performance in real time. The framework also provides the use of AI powered models for tasks such as automated grading resource recommendations and intelligent feedback. In line with the argument and AI can improve pedagogy by supplementing human teaching with data driven insights thus giving educators more time for mentoring and less for routine assessment tasks. At AATPC the application of AI in teaching is coupled with the establishment of ethical and compliance protocols that protect data privacy and ensure that access is fair. Merits of teaching and scalability are regularly measured to confirm the results. The aim is to have a curriculum that is not only flexible in terms of integrating technology but also capable of developing human skills such as creativity, collaboration and problem solving which are the core skills of the AI driven world[60].

The FMC7 Curriculum and Pedagogical Integration measures the gap between planned curriculum and actual teaching practices at TVET institutions. All respondents (100%) indicated that AI was not part of their existing curriculum therefore AI was not part of their curriculum. But, a majority of teachers (64.2%) said they use AI tools to support teaching. 16.4% said they use AI tools occasionally and smaller numbers of instructors reported no use at all (6.0%) or very rarely. It appears that this is an informal process at the instructional level and is not part of the curriculum. Regarding adaptive and personalized learning, most respondents considered AI to be beneficial to them very much, while others suggested moderate or little impact. 62.7% responded that they were prepared to implement AI into their classrooms likely through a lack of training. All respondents agreed that the current curriculum did not address specific AI skills relevant to industry indicating that the relationship between education and the needs of the workforce is not

aligned in TVET education and labor market. This gap between curriculum contents, instruction, practice and workforce needs suggests the need for reform in TVET curriculum, structured teaching practice and workforce needs to ensure the successful and efficient integration of AI in TVET programs.

4.11. Technological Infrastructure

A strong technological infrastructure is the basis of all AI integration work that has been successful[61]. At AATPC a major part of this work entails the review of all current technology assets the check for hardware, software capabilities and the update of digital networks to the level at which they will be able to support AI applications. The framework centers on the establishment of the systems which are scalable and interoperable and which can meet the ever changing needs of AI driven education. The institution network connectivity, data centers and computing facilities are the points where the assessment for building infrastructure starts. The technology roadmap is open to such possibilities as the acquisition of cloud based platforms for storage and computation, the implementation of reliable internet access and the assurance of compatibility between legacy systems and new AI technologies. AATPC is concentrating on the creation of durable infrastructure through vendor partnerships and technology standardization. The institution also takes an inclusive approach by making sure that accessibility is considered for all learners including those with disabilities. The migration and integration of technology systems are conducted in such a way that there is the least possible disruption of the existing operations. The members of the technical support teams receive training in order to be able to efficiently take care of the infrastructure and at the same time ensure that it is resilient and adaptable to an ever-changing technological environment.

TVET institutions have a strong base in ICTs for using AI particularly with regard to connectivity, hardware availability and support. Most respondents reported access to the internet (89.6%) computers and laboratories (94.0%) networks (82.1%) tech support staff (94.0%) backup power (85.1%), all of which provide a stable base for technology-enhanced learning. But, further advanced and sustainable ICTs are lacking. While 70.1% reported having access to servers or cloud computing only a significant portion have access. This suggests that they are good at least moderately prepared to implement advanced AI. Both licensed and updated software (61.2%)

and lack of regular updates (70.1%) indicate concerns about sustainability of the software environment. These findings show that TVET institutions are well-positioned to use basic or entry-level AI but struggle to move towards more complex and resource-intensive AI implementations. The qualitative findings reinforce these findings by showing difficulty in accessing advanced computing resources, software, and maintenance of systems.

4.12. Data Management and Governance

Since AI systems are data intensive, having effective Data Governance and Ethical Standards is indispensable. AATPC's framework is designed to ensure that all data handling, processing and storage activities are in compliance with both local and international regulations[62], [63]. Among the ethical considerations are fairness, transparency and accountability. The framework is equipped with provisions for data quality audits, security measures and the training of staff in the ethical use of data. Data governance mechanisms have been put in place to clearly delineate ownership, access rights and the accountability features. The use of ethical AI guidelines is one of the measures taken to prevent algorithmic bias and ensure that educational outcomes are fair. The states that the implementation of trustworthy AI calls for institutions to put in place ethical review mechanisms and stakeholders being informed about the implications of AI decisions. AATPC's strategy in data governance is consistent with these norms as it prioritizes human supervision and compliance auditing. Moreover, the college through its awareness programs both for staff and students is committed to the promotion of responsible data use. The intention is to create an environment that supports data-driven decision-making which is at the same time ethical and transparent. This approach guarantees that the use of AI is a trust enhancing rather than a trust diminishing factor in the institution of education and the educational sector as a whole. Results from the Data Management and Governance (FMC4) study indicated that stakeholders lack a basic but inconsistent knowledge about AI data security and reporting procedures in TVET institutions. The majority (68.7%) responded that they would report a suspicious behavior to the IT security team 26.9% that they would report to their department heads, and 6.0% that they would take no action. Uncertain about the right reporting channel, 16.4% of respondents were unsure of which channel to report and 6.0% said they would not take any action. When asked about AI security knowledge, most respondents correctly reported

periodic checks on the security of their IT systems and careful use of AI tools though many still had misconceptions about the safety of AI. Overall, though many respondents are aware of the need to report and basic cybersecurity many do not understand what governance structures or procedures to follow. This suggests that there is not a formal framework of data governance in TVET institutions that are clear guidelines, reporting procedures, and improved awareness programs to ensure a secure and responsible management of AI data.

4.13. Sustainability and Scalability

Sustainability and Scalability are about how AI can still be a solution to future needs. This also involves creating monitoring, evaluation and feedback systems. At AATPC we believe that innovation is going on constantly, and not just once. Scalability only comes when we gather performance data, evaluate results, and make corrections based on the evidence. Monitoring mechanisms are created to monitor the educational impact of AI tools in the learning environment and ensure that the results are within the goals of the institution. Sustainable education can be a solution where AI practices are embedded in daily operation, curriculum development and staff training. Scalable AI driven education should be a solution that incorporates the technical side as well as human potential. AATPC's model shows an example of sustainability with technology and learning. It also has environmental and social sustainability by supporting energy saving technologies and inclusive digital policies. AATPC keeps pace with technology and changes in the educational sector, therefore adapting its strategy for AI integration strategies.[64]. Interview result under the Sustainability and scalability (FMC8) dimension reveal that AI implementation planning, budgeting, system upgrades, personnel training and evaluation mechanisms are not yet deeply embedded in the institutional practices. Only a few respondents indicate that a comprehensive long term AI strategy is in place, while the majority see it as weak or non-existent. Most people think that there is not sufficient financial support to maintain AI initiatives, and system updates are carried out periodically which may at times compromise performance and security. In addition, formal Continuous professional development and result oriented monitoring and evaluation activities are hardly carried out continuously limiting the institution's long term capacity to maintain AI integration.

4.14. Ethical, Legal & Policy Framework

The ethical, legal and policy framework is the set of regulations that govern the responsible, transparent, and fair use of AI in TVET institutions. This feature guarantees that the AI integration at AATPC is in line with national ICT regulations, data protection laws and international ethical standards. Ethical AI policies recognize and address issues that include algorithmic bias, fairness, accountability and transparency especially in AI assisted assessment and decision, making processes. The rules of conduct are indispensable to delineate the use of AI by teachers and students in such a way that the indecent use, misuse or over reliance on the AI system and unethical practices can be prevented. Observance of the law will keep the institution away from regulatory risks at the same time giving students the rights to privacy and informed consent. Policy frameworks also offer support through clarity and consistency to institutional decision making and capacity building. Worldwide research and policy documents underscore the point that ethical governance is a precondition for trust, building and for making sure that AI becomes a positive factor for educational quality and social equity[65][66].

The Ethical, Legal and Policy Framework (FMC5) report reveals that knowledge about ethically responsible AI use, legal requirements and AI-related policies is mainly scattered and patchy among TVET institutions. More than half of respondents (86.6%) still regard misinformation to be the greatest risk of AI use which is why they see copyright problem (9.0%) and privacy issues (4.5%) as less relevant, showing they are probably not very familiar and in fact are only focusing on the risk aspects of AI. Regarding who should be held responsible for AI development and use there is quite a spread of opinions with 46.3% blaming AI developers and companies 43.3% pointing to users, and only a very small share seeing institutional leaders (9.0%) or government regulators (1.5%) as responsible which is a sign of low awareness of formal governance and policy accountability structures. Moreover, in very ethically challenging situations such as the request for personal data from AI one only a little over half of the respondents (55.2%) said that they would turn to the IT department while 16.4% would copy other people's actions 13.4% would comply with the request and 14.9% do not know what to do, so the level of ethical decision-making is far from consistent. In summary, this study reveals that despite the fact that people may be aware of some of the risks of AI, there is generally no clear or consensual understanding of the frameworks or rules regulating the use of AI in education. This definitely

calls for the institution of formal policies at the institution level, clear regulation by the authorities' at large and ethical training as part of a planned curriculum. All of this will be in line with the need to promote the responsible and legal integration of AI in TVET institutions.

4.15. Stakeholder Engagement

Stakeholder engagement refers to the capacity of an organization to recognize and involve all the people affected by their decision in the planning, execution and assessment stages of the AI initiatives. In the AATPC situation, stakeholders are students, teachers, institutional leaders, policymakers, industry partners, employers and technology experts together with other students. Their active participation aids in ensuring that AI tools are appropriate for the learning community and make the learning process more interesting rather than creating new difficulties to understanding or using the technology. Teachers and trainers through their experience can share the realities of the classroom and the pedagogical feasibility while management and policymakers ensure that everything is in line with institutional and national priorities.

Industry partners are essential in the TVET sector as they, by participating in the curriculum development process, ensure that the content is relevant, indicate the real world applications and support the internship and work based learning programs. Community and technology experts on the other hand can contribute their knowledge of the environment and provide technical support. Open stakeholder engagement creates shared ownership thus being a great advantage in the acceptance of AI initiatives and their sustainability over time. Stakeholder theory and education reform literature support the idea that real participation leads to higher effectiveness and legitimacy of institutional change processes[67][68]. The results related to the Stakeholder Engagement (FMC2) aspect indicate that there is a very positive perception and a high level of acceptance of the respondents towards the integration of AI in TVET education. Most of the respondents agree that AI can improve teaching and learning (88.1%) and it can make students' learning more effective (85.1%) whereas 79.1% welcomed its incorporation into the curriculum. Furthermore, a very large number (89.6%) showed their readiness to learn and use AI tools, and 85.1% reported using AI for the sharing of educational materials or collaboration, revealing the practical side of their engagement with AI. Nevertheless, equally significant but far less visible is the dimension of institutional alignment. The result is a bit striking as it shows that all the

respondents (100%) confirmed that there are no institutional standards, policies, or frameworks for guiding the integration of AI in TVET institutions. This clearly implies that AI adoption is mainly an individual effort rather than a part of a concerted institutional strategy. In summary, according to the results, although the stakeholders are highly supportive, motivated and actively engaged in the use of AI, the lack of formal governance structures adversely affects the consistency, effectiveness and sustainability of AI integration in TVET education.

4.16. Integration of Constructivist Learning Theory, TPACK and STS into the Framework

The proposed AI Integration Framework for TVET curriculum at AATPC draws on three theories: Constructivist Learning Theory, TPACK model and (STS) Theory. Together, they provide a basis for designing a learner-centered, technology-integrated and context-specific framework. Constructivist Learning Theory informs the design of the framework to promote active, practical and reflective learning. AI tools are used to support simulation-based training a learning experience that engages the user adaptive learning and feedback from the AI. Through this approach learners can actively construct knowledge through interaction, collaboration and real-world problem solving. Incorporating AI into teaching and learning using the TPACK model will ensure that instructors have the knowledge to integrate AI with pedagogy and material. The model can be used to help faculty develop, assist instructors in designing instruction and implement appropriate content-based AI tools.

STS provides a larger institutional and organizational perspective that emphasizes the interaction between technology, people and the institutional environment. It also involves elements of infrastructure building, stakeholder engagement, policy formation and governance in order to support sustainable and contextually appropriate deployment of AI. In this way Constructivist Learning Theory supports the learning process, the TPACK model guides the instructional process and STS Theory informs the institutional and systemic components of the framework. This ensures that the inclusion of AI in TVET education is learner-centered, pedagogically sound and aligned to the socio-technical context of Ethiopia specifically AATPC.

4.17. Chapter Summary

The chapter describe the analysis and interpretation of qualitative and quantitative data gathered from the participants of AATPC who shared their perspectives on the integration and readiness of AI in TVET education. The qualitative data were analyzed through thematic analysis and has unveiled major themes such as training gap, institutional barriers, positive impact, AI usage, future needs, psychological barriers, infrastructure issues and AI awareness. These themes are elaborated and complemented by the survey results of the eight major dimensions; Human Capacity, Stakeholder Engagement, Institutional Readiness, Data Management and Governance, Ethical Legal and Policy Framework, Technological Infrastructure, Curriculum and Pedagogical Integration and Sustainability and Scalability. According to the findings, the majority of the participants have a fundamental knowledge of AI that they have mostly gained through informal avenues like social media. Besides this, many of them are already utilizing AI-based tools such as ChatGPT for enhancing their learning and teaching activities. The perception towards AI is highly favorable. Most of the respondents see the potential of AI in making a positive contribution to the effectiveness of teaching, facilitating students' better access to learning resources, and giving support to their understanding. Other than that, a great readiness to embrace and learn the AI technologies was noticed in instructors and students alike.

However, the findings indicate that along with this positive attitude and initial readiness there are substantial issues that effectively prevent the further development of AI usage. There is very little institutional readiness in that most of the people surveyed pointed out that their institutions do not have any policies guidelines or strategic frameworks relating to AI. Besides that, governance frameworks are not strong and only a few leaders provide support for the merging of AI. Likewise, the human capacity is far from being sufficient as lots of the respondents have never been formally trained do not possess advanced digital skills and are unfamiliar with AI concepts and ethical issues. Although almost everyone has access to the basic ICT infrastructure such as computers, internet connectivity and tech support the implementation of more advanced AI solutions is greatly hampered by the lack of up-to-date technologies, the old computer programs, and the insufficient regular maintenance of the systems. Lastly, the study unmasked psychological barriers, in particular a reluctance to AI implementation that arises from a fear of losing one's job and a lack of trust in one's ability to work with digital technologies.

In addition to that, the results reveal a huge discrepancy concerning the curricular and teaching integration, as the AI is not formally part of the TVET curriculum even though the instructors use it informally. This points to change between the current educational methods and the labor market requirements that are changing. Besides that, the skills and practices for data management and governance are very low, there are many people who do not have consistent knowledge of cybersecurity, reporting and the ethical use of data. Also, there are very little ethical, legal and policy-related frameworks, so the use of AI in education responsibly cannot be relied upon to have specific guidelines. The use of AI has not been well thought out financially, and long-term strategies do not exist and as a result monitoring and evaluation mechanisms are weak which is why sustainability and scalability are also low.

In response to the problems raised this chapter sets out an all-round AI integration model that features eight co-dependent elements: Institutional Readiness, Human Capacity, Curriculum and Pedagogical Integration, Technological Infrastructure, Data Management and Governance, Ethical Legal and Policy Framework, Sustainability and Scalability and Stakeholder Engagement. This model is a product of research findings it corresponds to international standards and national ICT regulations and it is aimed at helping the organized, ethical and perpetual invasion of AI in the TVET sector. All things considered the research indicates that in addition to a good base of awareness, interest and positive perception of AI, there need to be major changes in the areas of institutional backing, skills enhancement, building up facilities and drafting policies to bring about effective and long-lasting incorporation of AI in TVET education. Thematic analysis of the qualitative data identified eight main themes of AI integration in TVET. Training gaps and institutional constraints were identified as the biggest barriers to AI implementation. Respondents said they perceived AI as beneficial in teaching and learning. AI use was found to be informal and unsupported. Increasing the effectiveness of AI integration requires training, infrastructure, policy support and awareness.

CHAPTER FIVE

FRAMEWORK EVALUATION, VALIDATION AND IMPLEMENTATION READINESS

5.1. Introduction

The chapter deals with evaluation, validation and readiness for the implementation of the framework proposed. The evaluation chapter describes the results from key informants and experts who evaluated the comprehensive, consistency, completeness and applicability of the framework. The validation process is checking if the framework sufficiently solves the research objectives and is consistent with theoretical and practical requirements. The implementation readiness evaluation explains the level of the college preparedness for the integration of the proposed framework. It focuses on the evaluation of the technology infrastructure, institutional capacity, policy support and overall willingness of stakeholders. The analysis is demonstrated with the help of tables, where each is accompanied by a summary description obtained from the data collected. The results are discussed concerning the research questions and objectives to determine the extent to which the framework can be developed and operationalized.

5.2. Evaluation of the Framework

The evaluation of the suggested AI integration framework for the TVET curriculum at AATPC was carried out to determine the completeness, contextual relevance and consistency of the framework with national and world educational standards. Besides, the evaluation of the proposed AI integration framework was initiated to ensure that it addresses the identified challenges in the Ethiopian TVET system particularly those related to the institutional readiness, human capacity development, curriculum and pedagogical integration, stakeholder collaboration, technological infrastructure, data governance, sustainability and scalability, ethical and legal considerations. The evaluation process incorporated expert validation, stakeholder feedback, policy alignment analysis and comparative evaluation against international frameworks of AI enabled education. The evaluation shows that the framework is conceptually robust, practically

feasible and strategically in line with the digital transformation objectives of the Ethiopian TVET system. Thus, to make sure that the proposed AI Integration Framework for TVET Institutions is comprehensively addresses the issues, relevant and practically usable the framework had been assessed by five ICT experts from the AATPC TVET College. These experts are highly knowledgeable professionals who have been dealing with information systems, digital infrastructure and technology governance for various years and hold a couple of professional certifications in the areas of AI and system management. The expert review method is in line with the framework validation methods that are well, established and trust on professional expert to evaluate conceptual reliability and practical applicability.

The proposed framework was thoroughly explained and evaluated including all of the component, sub-component and procedures involved in creating the framework the development process. Both questionnaires and semi-structured interviews were utilized for the evaluation. Applying a five point rating scale the questionnaire ranged the level from 1 (strongly disagree) to 5 (strongly agree) hence, the clarity, completeness and applicability of the framework were evaluated. The evaluation criteria are enclosed in the appendix. The main purpose of the interview part was to get qualitative feedback in detail and good understanding concerning the frameworks usefulness in TVET environments.

The semi-structured interview questions covered the following:

- Do you agree with the suggested framework's components and sub-components? Please explain their relevance to AI integration in TVET institutions?
- IS the framework comprehensive enough to support sustainable AI implementation?
- Do you think that the framework guides institutional AI adoption and governance? Through which mechanisms?
- What recommendations or improvements would you suggest?

Results of the evaluation were:

- Concerning the components and sub-components of the recommended criterion in the suggested AI Integration Framework the experts indicated that the framework contains essential elements or components for the long-term adoption of AI by TVET institutions.

They concurred that important aspects including human capability, infrastructure, governance, curricular integration and sustainability are sufficiently reflected in the framework. To properly comprehend the links between components, one expert stressed that users need consult both the framework diagram and the textual explanations, pointing out that graphical depiction might not offer enough information on its own.

- The experts also agreed that the framework was comprehensive, offering a complete and systematic description of the requirements for AI integration. They agreed that its relevance is strengthened when institutional demands are connected to pertinent best practices and governance principles. It was deemed suitable and inclusive to incorporate technological, ethical, policy and capacity-building components to direct institutional AI implementation.
- Regarding the framework's applicability and usefulness, the experts were confident that it would be a helpful manual for organizations without formal AI implementation methods. According to them, the approach can help TVET settings with systematic AI deployment, governance alignment and strategic planning.

One expert said, “This proposed AI integration framework would be a comprehensive guideline for the TVET colleges which have no formal structure to implement AI technologies.” Another expert emphasized the importance of the framework in terms of the structured implementation of the system, saying, “The approach would be able to help the TVET institutions to implement the AI system in a structured manner, which is aligned with the governance structures and strategic planning goals.” One expert also mentioned the importance of the context when implementing the system noting, “Some institutions may need additional context-specific information on how the AI governance policy aligns with their readiness and technology”. So, the framework was amended to consider the strategic and contextual requirements of integrating the AI system in the curriculum of AATPC. Accordingly, “It would be beneficial to provide examples of AI integration steps within the curriculum so teachers and administrators better understand the implementation process.” However, after further discussion, all the other experts and researchers agreed that if the framework was excessively developed the flexibility and scope of the framework would be limited. The framework was considered as a conceptual guide.

- The experts also supply a few minor changes in the display and transparency as their extra feedback and advice. In order to improve the understandability and make clear the interplay among different components, a few of the suggestions have to be about using highlighting for one or two specific connections. Besides that, some people speak about the enhancement of the framework through application to the real world and conduction of pilot tests, instead of thinking of conceptual development only, as a means of achieving the goal of "more applicability and flexibility". On the whole, the result of the assessment reveals the fact that this conceptual framework is a valid, reliable and appropriate model for institutions AI integration. Nevertheless, regular revisions and tests are required in order to not only maintain its suitability but also improve the productivity of the framework.

The framework was also subjected to a policy alignment review which is an important aspect for integration into the Ethiopian TVET system. The MOLS is focusing on the curriculum modernization, the incorporation of digital technology with the advocacy of competency based training. The National Artificial Intelligence Institute[69], promotes the deployment of AI in the education sector in a responsible and inclusive manner. The framework under discussion is in line with these national directives as it indicates in detail various aspects such as capacity building, ethical AI use, competency, based AI curriculum integration and governance structures that are capable of supporting the institutionalization of AI technologies. Such alignment, therefore, contributes to institutional acquisition and long term sustainability of the national TVET modernization agenda.

A comparative evaluation with international frameworks further validated the robustness of the framework. The proposed framework aligns with the [70]“AI and Education Recommendations” the [71]“Principles for Responsible AI” and [72] AI Management System Standard. These global frameworks emphasize transparency, accountability, fairness and human centered design principles that are embedded within the ethical and governance components of the AATPC framework. Additionally, comparison with the AUDES[73] showed that the framework supports regional priorities concerning digital literacy, infrastructure expansion and workforce development.

To test the practical feasibility of the proposed framework a small-scale pilot implementation of AI-supported lesson planning, automated assessment generation, and administrative reporting was conducted. The pilot implementation involved 5 participants consisting of TVET instructors and ICT personnel selected from the participating institutions. The activity was carried out over a period of approximately three hours in a controlled workshop setting. During the pilot implementation participants engaged in structured, task-based scenarios reflecting real TVET instructional and administrative processes. In the lesson-planning task, instructors developed session plans using AI-assisted templates aligned with selected curriculum modules. In the assessment task, participants generated quizzes, short-answer questions, and practical evaluation items using AI tools based on competency standards. In the administrative reporting task, participants produced sample student performance reports using predefined datasets to simulate institutional reporting requirements. Teachers and ICT personnel then reviewed the AI-supported outputs and judged them usable, supportive of learning outcomes and adaptable with appropriate training. During the workshop, participants interacted with AI tools such as ChatGPT for content generation, question answering and instructional support. Sample activities included generating lesson plans, creating assessment questions, and explaining technical concepts using AI assistance. The primary AI tool used in this proof-of-concept was ChatGPT, which was utilized for generating instructional materials, answering domain-specific questions and supporting interactive learning scenarios. Despite identifying challenges such as low baseline digital literacy and limited device availability, stakeholders agreed that these barriers are consistent with national digital readiness assessments and can be addressed through the framework's capacity-building and stepwise implementation strategy. The evaluation criteria were utility and applicability, consistency with institutional context, content validity, and overall usefulness of the framework. The content of the questionnaire is from the evaluation criteria recommended by [74], [75], [76]. Concerning the skewed lower rating should be 6 (1 lower mark x 6 experts = 6), the higher skewed rating should be 30 (5 x 6 experts = 30), and the average rating should be 15. Overall, these ratings are positive and acceptable by experts. Figure 5.1 shows all the above-average ratings.

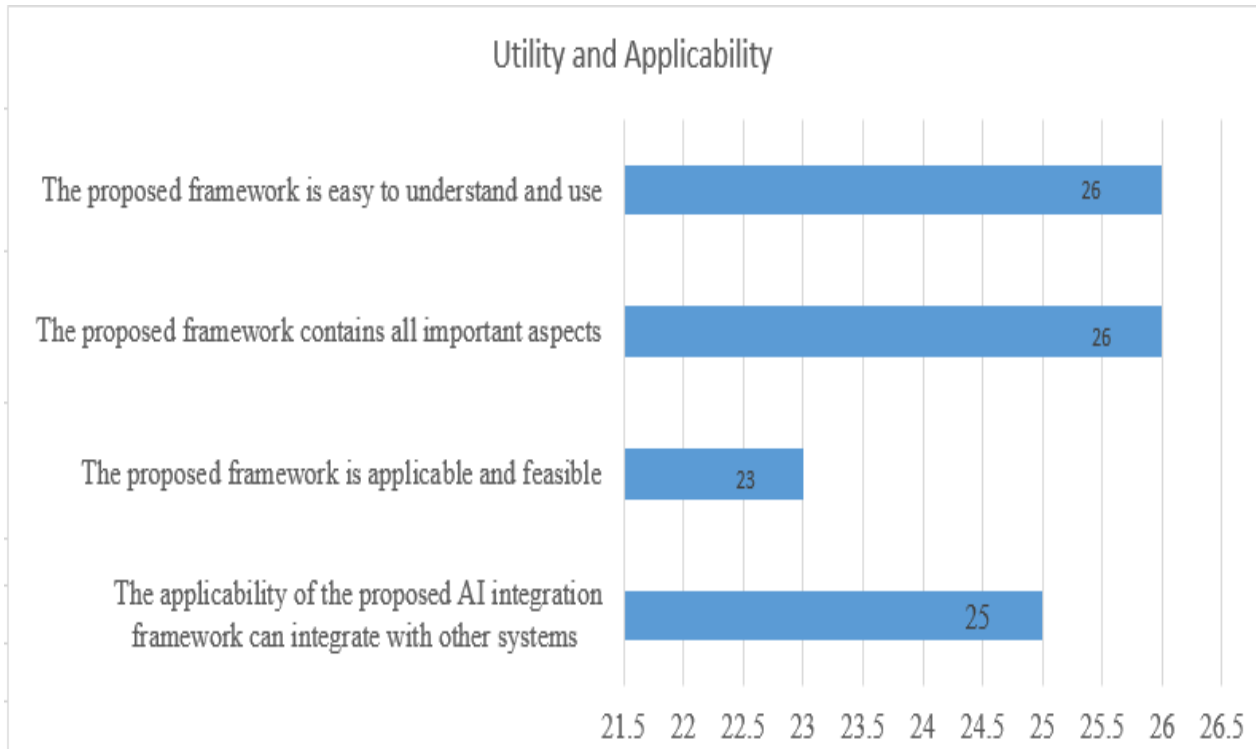


Figure 5.1: Evaluation Result for Framework Utility and Applicability

Figure 5.1. Above shows that the frameworks were useful and practical. They were easy to understand and it was practical. The criteria of Consistency with people checks the frameworks utility, understandability, ease of use and ethics against the users or stakeholders working at AATPC. To summarize the evaluation statistically the mean score was calculated as 24.6 which reflects a generally high level of agreement among experts regarding the quality of the framework. This suggests that the overall perception of the proposed AI integration framework is strong and satisfactory. In addition, the standard deviation was computed as 1.4142 which indicates a low level of variation in the expert ratings. This small spread implies that the experts' evaluations were closely aligned, demonstrating a high level of consistency and agreement in their judgments. Overall, the results indicate that the proposed framework is well-structured, accurate, and comprehensive and is considered suitable for implementation within TVET institutions.

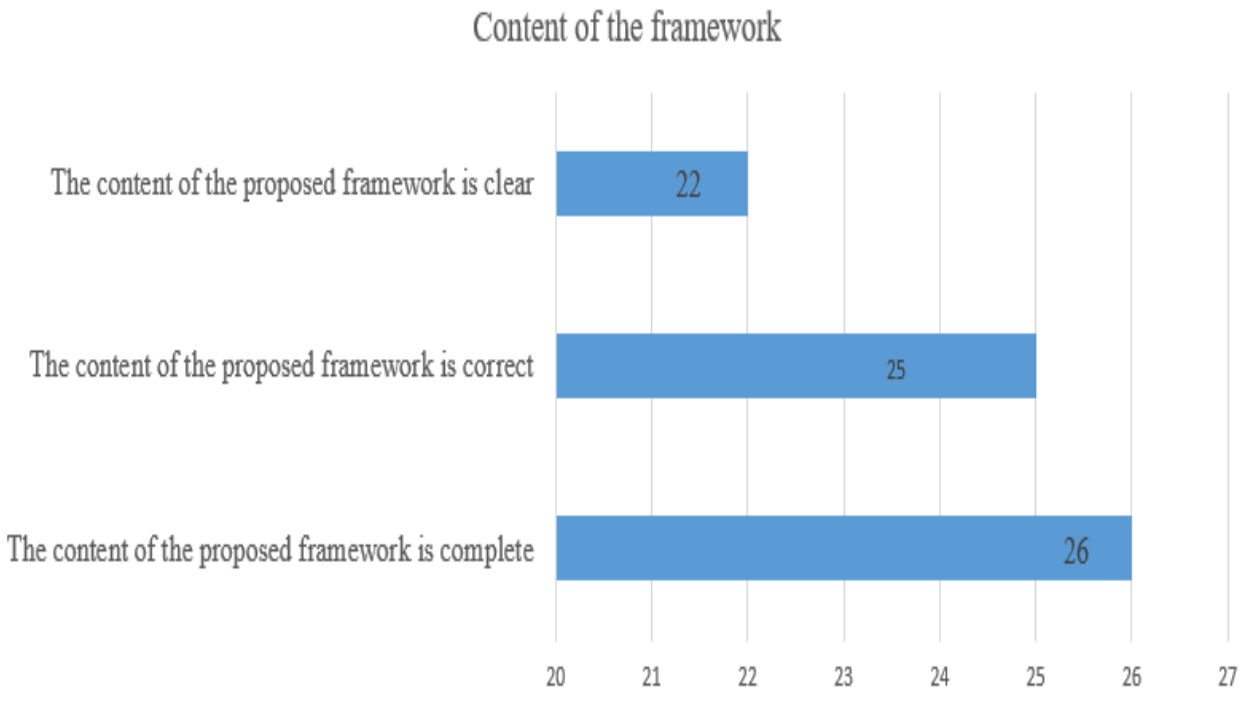


Figure 5.2: Evaluation Result for the Content of the framework

The above figures (figure 5.2) shows the evaluation framework contents are clear, correct and complete for users/stakeholders and others at AATPC. The quality of the content in the proposed framework was assessed on the following three dimensions such as clarity, correctness and completeness. The framework scored 22 for clarity, 25 for correctness and 26 for completeness. These scores indicate that the framework was assessed well across all aspects. To provide a statistical summary of the assessment we computed the mean score as 24.33 which implies that the overall perception of the content in the framework was strong and satisfactory. We also computed the standard deviation as 2.08 which indicates a relatively low variation between scores, suggesting that the experts were unanimous in their assessment of the framework. The outcomes show that the content of the proposed AI integration framework is clear, accurate and comprehensive and is suitable for TVET.

Conclusion: The evaluation revealed that the AI Integration Framework for AATPC TVET Curriculum is comprehensive, suitable and practical in addressing the national TVET needs,

global AI in education standards and emerging digital skill learning trends. They acknowledged that the AI Integration Framework for AATPC TVET Curriculum is well-designed and organized and directly relevant to AATPC's efforts to promote an AI-enabled teaching and learning environment. While there are still some issues, the framework can be applied gradually to make AI integration feasible and desirable in the Ethiopian TVET Education System.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1. Introduction

In this chapter, the conclusions of this study are discussed along with recommendations. Conclusions are based on the findings of research and the professional's evaluations of the framework. They suggest the steps from the findings to answers towards questions and goals for research set in the thesis. Besides that, the chapter puts forward a few practical suggestions that were the result of an in, depth analysis and validation of the framework.

6.2. Conclusion

This study aimed to develop an AI integration framework into TVET curricula using the case study of AATPC TVET College. This was done due to the need of TVET institutions in Ethiopia to respond rapidly to digitalization and labor market changes. The study confirmed that AI has the potential to contribute significantly to teaching, learning, skills acquisition and institutional effectiveness within TVET. In the survey and interview data it was found that AATPC is very much ready for AI integration. The survey results reveal a generally positive attitude among teachers and students towards learning and using AI tools indicating strong motivation for digital change. The interview results clearly confirm this with positive attitude on display a desire to learn and use AI tools. The qualitative findings revealed collaboration among academics and new interest in using technology-enhanced teaching practices.

Nevertheless, this study highlighted several main challenges that can act as barriers to the successful integration of AI. They consist of minimal integration of AI materials into the curriculum, very low levels of AI skills among teachers, lack of modern teaching technologies, and very few chances for professional development. The institutions have only basic ICT facilities like computers and the internet but they wish to learn first about AI and then be able to integrate it well in their systems. The study point out that even though these problems pose a

threat the study quite clearly shows that technological provision alone is not the only factor influencing the successful integration of AI in TVET rather it is also a combination of institutional readiness, curriculum alignment and human capacity development. TVET staff members' limited AI literacy is also a major challenge. Furthermore, while computers and internet facilities are the ones most frequently at TVETs, the overall institutional readiness for AI integration is still at a very early stage. As for AI's role in TVE it is capable of providing a broad spectrum of benefits such as personalized learning, adaptive assessment, virtual simulation, administrative efficiency, predictive analytics, lifelong learning support, accessibility and data-driven decision-making. The continuing development of these features should be one of the main focuses of TVET institutions. So, these benefits not only give them the motivation to introduce AI but also make them realize that AI can be a powerful tool for the delivery of quality, efficient and responsive vocational education and training.

6.2a. Achievement of the Specific Objectives

This study set four specific objectives. The table below shows how each was addressed:

Table 6.1: Achievement of the Specific Objectives

No	Specific objective	How it was addressed (method)	Where it is reported
1	To assess the current practice of AI integration and the level of AI awareness in the curriculum at AATPC.	Questionnaire (n = 67) and semi-structured interviews, FMC1 (Human Capacity) and AI-Awareness theme.	Table 4.3-4.5, Tables 4.4, 4.8, theme “AI Awareness”.
2	To evaluate the institutional readiness of AATPC for integrating AI into its curriculum.	Administrator interviews and readiness survey items in FMC3.	Table 4.8 (Institutional Readiness), Table 4.6.

3	To identify the key challenges affecting the implementation of AI in the TVET curriculum at AATPC.	Thematic analysis of interview and focus-group data, open-response survey items (Tables 4.12, 4.13).	Table 4.5 (Themes 4.5.1–4.5.8).
4	To develop a contextualized framework for effective integration of AI into TVET curriculum at AATPC curriculum.	Design-science synthesis of findings, expert evaluation (n = 5), policy-alignment and comparative review, proof-of-concept workshop.	§4.6–4.7 (components); Figure 4.3 (framework); Chapter 5 (evaluation).

6.2b. Answers to the Research Questions

RQ1: what are the current practices of AI integration and the level of AI awareness in the TVET curriculum at AATPC?

AATPC has no formal curriculum for AI (100% of respondents confirmed it), but 67.2% said they have used generative AI tools such as ChatGPT and 86.1% said they have used AI for learning. While AI awareness is moderate at 41.8%, those who reported being medium-to-slightly familiar with AI only think about machine learning 55.2%. Integration is also informal, individual led and out-of-classroom.

RQ2: What is the level of institutional readiness of AATPC for integrating AI into its curriculum?

IT infrastructure is available or partial (94 percent of respondents have a computer, 89.6% have the internet, and 94%), but only 26.9% say they have AI or digital content in their course; 100% say there are no institutional policies or guidelines regarding AI, only 26.3% say the governance structure is ready for digital change.

RQ3: What are the key challenges affecting the implementation of AI in the TVET curriculum at AATPC?

The eight challenges listed included: lack of training, institutional barriers, lack of policy, and infrastructure for advanced AI; psychological barriers (fear of displacement), lack of awareness of AI, lack of governance of data and weak sustainability/scalability. The two most frequently used codes were Training gap and Institutional barriers.

RQ4: How can a contextualized framework be developed for effective AI integration at AATPC?

Institutional Readiness, Human Capacity, Curriculum & Pedagogy, Technological Infrastructure, Data Management & Governance, Ethical/Legal & Policy, Sustainability & Scalability, Stakeholder Engagement and Social Innovation. The eight components are based on Constructivist Learning Theory, TPACK, and STS and evaluated by five domain experts. The framework is in compliance with UNESCO, OECD, ISO/IEC 42001, and AU AUDES (Figure 4.7) and Chapter 5 reports its evaluation.

6.3. Novelty and Contributions of the Study

This study makes four contributions that distinguish it from the existing literature:

- A context-specific AI integration framework for Ethiopian TVET. Unlike the previous models focused on high-income or resource-rich societies such as Singapore, Germany, China, this model utilizes eight components in response to infrastructure, pedagogy, policy and capacity constraints typically encountered in developing-country TVET institutions using AATPC as the model.
- A socio-technical integration of three theories: Constructivist Learning Theory (to support learner-centered, experiential use of AI), TPACK (to support the instructor’s use of AI) and STS (to support institutional integration). Prior research on AI-in-TVET has focused on only one of these theories.
- Artifact validated on the basis of primary data from 67 stakeholders at AATPC, validated with quantatives and qualitative analysis using thematic analysis and tested by five ICT experts on four criteria aligned with Ethiopian national policy (MoLS, National AI Institute), benchmarked against UNESCO, OECD, ISO/IEC 42001 and AUDES.

- A policy-to-practice bridge. The framework translates the national strategy on digital transformation into institutional level indicators and named responsible actors (Table 4.14). This bridge bridges the gap between policy in Ethiopia’s Digital Strategy 2025 and practice (high-level guidance on digital transformation) identified in the country’s Digital Strategy 2025.

It is important to note that previous research has focused on either the technology of AI in education or the policy envelope. This study aims to bridge those two fields with a locally-rooted, expert-validated model that can be implemented slowly.

The comparison highlights several differences. First, while previous studies generally approach issues from a global or broad perspective, this study takes a contextual and interdisciplinary view of TVET in Ethiopia. Second, where these studies focus on technological or pedagogical issues, this study focuses on socio-technical issues that integrate institutional, human and technological factors. Also most previous researches have relied on secondary data, whereas the proposed framework is built on primary data collected from students and faculty, which makes it more pragmatically relevant. In terms of governance, past researches often did not take data governance, ethical and legal policy into account; this study has addressed the governance of data, ethics and law in its planning. Infrastructure problems are rarely addressed in the literature and are central to the proposed framework. Finally, many of the previous models are conceptual in nature while the proposed model is anchored on practical and will be practical in TVET institutions. This comparison highlights that this study moves the existing literature by providing a context-specific, empirically grounded and operational framework for AI integration in TVET institutions.

6.4. Recommendations

The results of this research could be for great assistance to AATPC in curriculum delivery, digital readiness and sustainable AI integration in TVET education. AI integration framework suggested below can either be followed implemented or modified slightly depending upon the needs and resources of the college. The following recommendations are submitted to the college:

- The college should regularly conduct AI and digital skills training for instructors, ICT staff and academic leaders.

- The college should provide technical support services to teachers and students in the use of AI tools.
- The college needs to set up policies and technical guidelines for the responsible and fair use of AI technologies in teaching and learning.
- College management needs to reflect great leadership and commitment in support of inclusion of AI in TVET curriculum.
- AATPC should upgrade the institutions ICT infrastructure with reliable internet, computer labs and digital learning platforms.
- The institution should revise the curriculum periodically to include AI related skills that match needs of the sector.
- The institution should allocate a budget for integration of AI technologies so that ICT infrastructure, training and digital learning activities are ready to support the successful implementation of AI at AATPC.
- The institution should establish Cooperation with industry partners, universities and government organizations should be further developed to help with hands-on training in AI.
- The approach proposed should be adapted when possible to institutions with differing capabilities, structures and perspective.

6.5. Limitations of the Study

This study was limited to only one TVET institution AATPC which was chosen due to limited time and resources. The study mainly looked at the teaching and learning aspects of the institution and came up with a framework that integrates AI into its curriculum. Other sides of the institution and other TVET colleges in Ethiopia were not include. Hence, the focus on one college might limit the ability to generalize the findings as AATPC may not represent the diversity of resources, technological capacity and staff expertise in the entire TVET sector. Besides that, the framework was reviewed by a fairly small number of experts, so it might not thoroughly represent wider stakeholder viewpoints. Though the framework can be used at AATPC its use in other institutions might be limited due to differences in the context, capacity and willingness of the institutions.

6.6. Future Works

The objectives of this study were to develop a curriculum for TVET at AATPC including AI through descriptive analysis and user feedback. Future studies may assess the effectiveness and challenges of AI supported teaching and learning in TVET institutions. Future research may include TVET colleges and training institutions across Ethiopia to develop a more generalized framework for the integration of AI into education suitable for developing countries. Further research may also include education technologies, advanced digital infrastructure, adaptive learning technologies and new AI based education tools for curriculum delivery and student learning. Future researchers are encouraged to evaluate policy, ethical, economical and institutional readiness factors that influence sustainable AI adoption in technical and vocational educational systems.

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Appendix

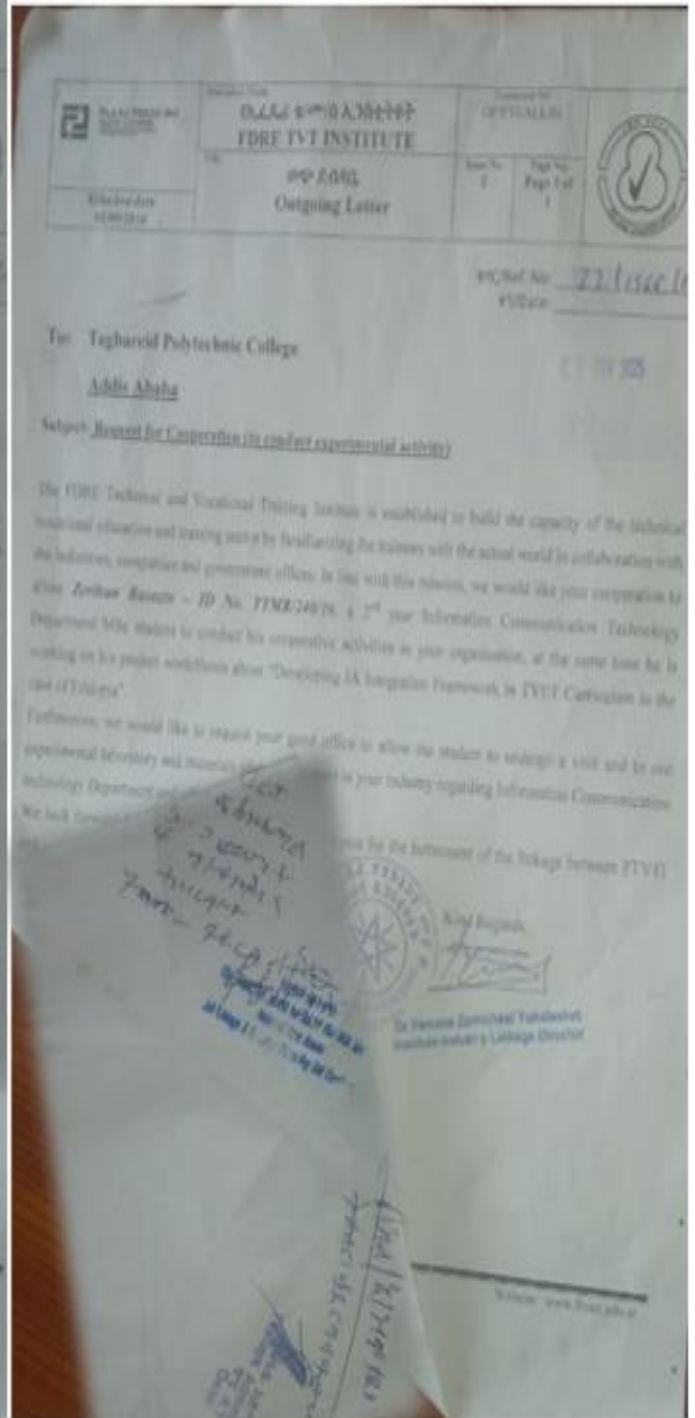
General Category Questionnaire

Questionnaire on Developing AI Integration Framework in TVET Curriculum: The Case of AATPC.

Dear Respondent,

I am Zerihun Basazin, postgraduate student pursuing a Master's of Science in Information Technology at FTVETI in Ethiopia. I am conducting a research study titled Developing an AI Integration Framework in TVET Curriculum: The Case of AATPC. Through your involvement with TVET as a student, teacher or staff member, you have been chosen to participate in this study. My research aims to explore the conditions, readiness, and difficulties in incorporating AI in the TVET Curriculum at AATPC. All information you give me will be treated as confidential and used only for educational purposes. You can participate or abstained your participation at any time.

If you need any help or explanation, please do not hesitate to contact me via one of the email addresses below. Tel: 0919315619; Email: zerihunbasazin@gmail.com



Appendix I

Questionnaire for student, Teacher and Staff

Part 1: Demographic Information. (ክፍል 1: የስነ-ሕዝብ መረጃ)

1. What is your gender? (ጾታዎ ምንድን ነው?)
 Male Female
2. What is your age group? (ጾታዎ ምንድን ነው?)
 Below <=20 21–30 31–40 41–50
3. Which department are you in? (በየትኛው ዲፓርትመንት ውስጥ ነዎት?)
 ICT
 Electrical & Electronics
 Automotive
 Garment & Textile
 Manufacturing
 Other _____
4. What is your role? (የእርስዎ ሚና ምንድን ነው?)
 Student
 Teacher
 Department Head
 Staff
5. How many years of experience do you have in this role? (በዚህ ሚና ውስጥ ስንት ዓመት ልምድ አለዎት?)
 0–2 3–5 6–10 11+ Not applicable

Appendix II

Please write the appropriate answer.

Questions for Interview (ለቃለ መጠይቅ የሚሆኑ ጥያቄዎች)

1. How did you first learn about AI and do you use tools like ChatGPT in your studies?
2. Does your college provide AI training or guidance for students and instructors?
3. In your opinion, how does AI affect teaching and learning in your institution?
4. What are your views about AI replacing teachers or changing the teaching role?
5. How would you describe the availability of ICT infrastructure (computers, internet, and software) in your college for AI use?
6. How do you use AI tools in your academic activities (formally or informally)?
7. Does your institution have any policy or guideline for using AI in teaching and learning?
8. How do you see the role of AI in the future of education in your college?
9. Why do you think some teachers or students resist using AI technologies?
10. What kind of training or support do you think is needed for effective AI integration in your institution?

Part 2: AI Awareness & Digital Skills. (የአይቲ ግንዛቤ እና ዲጂታል ክህሎቶች)

1. How familiar are you with Artificial Intelligence (AI)? (ከአርቲፊሻል ኢንተሊጅንስ (AI) ጋር ምን ያህል ያውቃሉ?)
a. Very Low b. Low c. Medium d. High e. Very High
2. Have you ever used an AI tool (ChatGPT, Gemini)? (የ AI መሳሪያ (ቻትጂፒቲ፣ ጀሚኒ፣ ወዘተ) ተጠቅመህ ታውቃለህ?)
a. Yes b. No c. somehow
3. Rate your digital/computer skills? (የዲጂታል/ኮምፒውተር ክህሎቶችዎን ደረጃ ይስጡ?)

- a. Very Low b. Low c. Medium d. High e. Very High

Part 3: Attitude towards AI Integration (ክፍል 3: ለ AI ውህደት ያለው አመለካከት)

No	Criteria	Yes	No	Some how
1.	AI can improve teaching and learning at TVET colleges.			
2.	AI will help students learn more effectively.			
3.	AI should be included in the TVET curriculum.			
4.	I am willing to learn and use AI tools.			

Part 4: Curriculum & Organizational Readiness

No	Criteria	Yes	No	Some how
5.	The current curriculum includes digital or AI-related content.			
6.	The college is prepared to integrate AI into teaching.			
7.	There is institutional support for digital transformation.			
8.	There are enough guidelines or policies for AI integration.			

Part 5: Infrastructure Readiness

No	Criteria	Yes	No	Some how
9.	The college has enough computers for digital learning.			
10.	Internet speed and reliability support AI-based tools.			
11.	There are adequate digital learning resources (LMS, smart labs, etc.).			
12.	ICT support staff are available for technical assistance.			

Part 6: Challenges of AI Integration

No	Criteria	Yes	No	Some how
13.	Lack of digital infrastructure			
14.	Lack of AI-related training			
15.	Poor internet connectivity			
16.	Lack of AI curriculum			
17.	Resistance to new technology			

18.	Limited budget for digital innovation			
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Appendix III

AI Safety, Usability & Access (AI Specific).

No	Criteria	Yes	No	Some how
19.	AI tools used in the college are safe for users.			
20.	Misuse of AI tools can be easily reported.			
21.	AI systems protect student and staff data.			
22.	AI tools are accessible to authorized users when needed.			

Appendix IV

Lesson Plan

Introduction to Computers

Course: Introduction to Information and Communication Technology (ICT)

1. Overview Computers are electronic devices designed to process data and perform tasks according to a set of instructions called programs. They are essential tools in modern education, business, communication, and daily life.

2. Learning Outcomes By the end of this topic, students should be able to: 1. Understand the definition and components of a computer. 2. Identify different types of computers. 3. Explain the basic functions of a computer. 4. Recognize input, output, and storage devices. 5. Understand the role of the operating system and software applications.

3. Components of a Computer - Hardware: The physical components including the CPU, monitor, keyboard, mouse, storage devices, and other peripherals. - **Software:** Programs and operating systems that instruct the computer on how to perform tasks. - **Users:** People who interact with the computer.

4. Types of Computers - Supercomputers: Extremely fast, used for complex calculations. - **Mainframes:** Large computers used by organizations for bulk data processing. - **Personal Computers (PCs):** Desktops and laptops for individual use. - **Workstations:** High-performance PCs for technical or scientific applications. - **Mobile Devices:** Smartphones and tablets with computing capabilities.

5. Functions of a Computer 1. **Input:** Receiving data from the user or other sources. 2. **Processing:** CPU processes data according to instructions. 3. **Storage:** Saving data temporarily (RAM) or permanently (hard drive, SSD). 4. **Output:** Presenting information via monitors, printers, or speakers. 5. **Control:** The operating system and software manage all activities.

6. Input Devices - Keyboard - Mouse - Scanner - Microphone - Webcam

7. Output Devices - Monitor - Printer - Speakers - Projectors

8. Storage Devices - Hard Disk Drive (HDD) - Solid State Drive (SSD) - USB flash drives - Optical media (CD/DVD)

9. Operating Systems and Software - **Operating System (OS):** Windows, Linux, macOS; manages hardware and software resources. - **Application Software:** Word processors, spreadsheets, web browsers, educational tools.

10. Conclusion Understanding the basic components, types, and functions of computers is fundamental for ICT learners. This knowledge lays the foundation for further studies in computer applications, programming, networking, and AI integration.

Assessment Questions for “Introduction to Computers” (ICT Course)

Quiz Questions:

Multiple Choice: 1. Which of the following is an input device? - A) Monitor - B) Keyboard - C) Printer - D) Speaker

2. What is the primary function of the CPU?

- A) Store data permanently
- B) Process instructions and data
- C) Display output
- D) Connect to the internet

3. Which type of computer is designed for large-scale calculations and scientific research?

- A) Personal Computer
- B) Supercomputer
- C) Workstation
- D) Mobile Device

Short Answer: 1. Explain the difference between hardware and software. 2. List three types of storage devices and their functions. 3. Describe the role of an operating system.

Lab Exercise: 1. Identify and label the following computer components: CPU, monitor, keyboard, mouse and storage device. 2. Perform a basic operation using the operating system (such as create a folder, save a file, and open it).

Assignment: 1. Write a short essay explaining the different types of computers and their primary functions. 2. Create a table listing input devices, output devices and storage devices with examples.

Instructor Notes: - AI will automatically grade multiple-choice questions. - Lab exercises will be monitored by AI for accuracy and completion. - Assignments will be evaluated using AI-assisted analysis for completeness and correctness with detailed feedback.

Administrative Report for “Introduction to Computers” (ICT Course)

Student Performance Summary:

Student Name	Attendance	Quiz Score	Lab Score	Assignment Score	Overall Performance	Remarks
Student A	95%	90%	92%	88%	Pass	Excellent progress
Student B	90%	85%	80%	82%	Pass	Good performance, minor improvements needed
Student C	88%	75%	78%	70%	Pass	Monitor progress, needs additional support
Student D	92%	80%	85%	78%	Pass	Satisfactory performance
Student E	85%	70%	72%	68%	Pass	Requires focused guidance

Report Description: - AI collects data from quizzes, lab exercises and assignments. - Attendance is recorded and integrated into overall performance. - Performance metrics are summarized to highlight students who need additional support. - The report provides actionable insights for instructors to adjust teaching and interventions.

Instructor Notes: - Review students flagged for additional support. - Monitor overall trends and individual progress. - Use AI-generated insights to enhance course delivery and personalized guidance. - Update the report periodically to track improvements over time.

Appendix V

Evaluation standards for the framework

Put a number (1-5) for your evaluation in the appropriate box of evaluation criteria. Choose (1) strong disagree, (2) disagree, (3) neutral, (4) agree and (5) strong agree.

Standards (Criteria)	1	2	3	4	5
Practical Utility and Contextual Relevance (Applicability)					
The proposed AI integration framework is clear and easy to understand.					
It includes all essential components needed for AI adoption.					
It is practical and feasible for TVET colleges.					
It integrates well with existing digital systems.					
Consistency with the College					
The framework fits Tegbareid TVET College's environment.					
It aligns with current technological trends.					
Content Quality					
The framework content is clear.					
The content is correct.					
The content is complete.					
Usefulness					
It helps guide AI integration activities.					
It helps identify tools needed for AI adoption.					
It improves understanding of AI integration processes.					

The python Code of the Qualitative data analysis

Snnipt Python Code

```
# STEP 1: Import libraries
import pandas as pd
import matplotlib.pyplot as plt

# STEP 2: Define and Load dataset from hardcoded data
data = {
    "Respondent": ["R1", "R2", "R3", "R4", "R5", "R6", "R7", "R8", "R9", "R10"],
    "Q1": ["Social media/ChatGPT", "Friends/rare use", "College
exposure", "Online discovery", "YouTube", "Social
media", "Online", "Friends", "Online platforms", "Mixed sources"],
    "Q2": ["No formal training", "No structured training", "Very limited
guidance", "Occasional workshops", "No training", "No formal training", "No
training", "Minimal training", "No structured training", "No training"],
    "Q3": ["Improves understanding", "Learning easier", "Supports
assignments", "Improves efficiency", "Explains topics", "Faster
learning", "Improves learning", "Helps understanding", "Enhances
learning", "Improves access"],
    "Q4": ["AI cannot replace teachers", "Teachers necessary", "Supports
teachers", "Role may change", "Teachers important", "Teachers needed", "Human
role remains", "Teacher essential", "Supports teachers", "Teachers
important"],
    "Q5": ["Basic ICT", "Limited ICT", "Unstable internet", "Not enough
computers", "Moderate ICT", "Internet issues", "ICT available", "Weak
infrastructure", "Basic ICT", "Moderate systems"],
    "Q6": ["ChatGPT use", "Rare use", "Summaries", "Writing
support", "Research help", "Assignment help", "Study support", "Occasional
use", "Writing support", "Research use"],
    "Q7": ["No policy", "No guideline", "Not implemented", "No clear
policy", "No guideline", "No policy", "No framework", "No policy", "No
guideline", "No policy"],
    "Q8": ["Improve education", "Important future", "Transform
learning", "Widely used", "Supports teaching", "Will grow", "Future
integration", "AI expansion", "Future adoption", "Integration future"],
    "Q9": ["Lack knowledge", "Fear technology", "Poor training", "Lack
awareness", "Resistance", "Limited skills", "Fear AI", "Lack
knowledge", "Digital fear", "Resistance"],
    "Q10": ["Workshops", "Continuous training", "Practical training", "ICT
skills", "Workshops", "Training", "Capacity
building", "Workshops", "Training", "Continuous training"]
}
```

```

df = pd.DataFrame(data)

print("Preview Data:")
print(df.head())

# STEP 3: Combine ALL responses (Q1-Q10)
text_data = df.iloc[:, 1:].stack().dropna()

# Convert to lowercase
text_data = text_data.str.lower()

# STEP 4: Improved thematic codes (VERY IMPORTANT)
codes = {
    "training_gap": ["training", "workshop", "skill", "development"],
    "psychological_barrier": ["fear", "resist", "afraid", "change"],
    "institutional_barrier": ["policy", "guideline", "support",
"management"],
    "infrastructure_issue": ["internet", "computer", "infrastructure",
"device"],
    "ai_awareness": ["learned", "know", "aware", "exposure"],
    "ai_usage": ["use", "using", "chatgpt", "tool"],
    "positive_impact": ["improve", "enhance", "support", "benefit"],
    "future_need": ["future", "need", "required", "important"]
}

# STEP 5: Count themes (allow multiple matches per response)
code_counts = {key: 0 for key in codes}

for response in text_data:
    for code, keywords in codes.items():
        if any(keyword in response for keyword in keywords):
            code_counts[code] += 1

# Convert to DataFrame
code_df = pd.DataFrame(list(code_counts.items()), columns=['Code',
'Frequency'])

print("\nCorrected Theme Frequency:")
print(code_df)

# STEP 6: Plot bar chart (no color specified)
plt.figure()
plt.bar(code_df['Code'], code_df['Frequency'])
plt.xticks(rotation=45)

```

```
plt.title("Thematic Analysis of AI Integration in TVET")
plt.xlabel("Themes")
plt.ylabel("Frequency")
plt.tight_layout()
plt.show()

# STEP 9: Save results
code_df.to_excel("corrected_thematic_output.xlsx", index=False)

# Download result
files.download("corrected_thematic_output.xlsx")
```