EVALUATING OBE STUDENTS LEARNING CAPACITY IN HIGHER EDUCATION: TOWARDS COMPREHENSIVE FRAMEWORK

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Evaluating OBE Students Learning Capacity in Higher Education: Towards Comprehensive Framework

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Candidate of **Master of Science in Software Engineering (MSSE)** at the National University of Modern Languages do hereby declare that the thesis **Evaluating OBE students learning capacity in higher education: towards comprehensive framework** submitted by me in partial fulfillment of MSSE degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in the future, be submitted by me for obtaining any other degree from this or any other university or institution. I also understand that if evidence of plagiarism is found in my thesis/dissertation at any stage, even after the award of a degree, the work may be canceled and the degree revoked.

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ABSTRACT

Evaluating OBE students learning capacity in higher education: towards comprehensive framework

Outcome-Based Education (OBE) is adopted in higher education to make sure that students acquire knowledge and skills that are useful for their future profession. Several strategies based on theoretical frameworks have been developed to improve education in higher education over the past two decades. Outcome-Based Education (OBE) aims to establish specific learning objectives that students are expected to achieve by the end of their educational journey and is also helpful for professional careers. Therefore, OBE approach develops the practical experience of students by integrating educational knowledge with practical skills. There is a lack of studies on the investigation of students' learning capacity and practical skills of OBE graduates in a real environment. To fill the research gap, this study aims to measure attainment of students' learning capacity and practical skills in OBE. Survey research is used to achieve research objectives. The survey respondents are employers of OBE graduates. A total of 140 employers participated in the survey. The result analysis of survey demonstrate that OBE graduates possess practical skills and learning capacity that enables them to effectively perform in real work environment. The research provides a systematic approach to assessing educational outcomes and guides the practitioners towards effectiveness of OBE. In the future, researchers can specifically measure student’s performance in OBE and assess other factors like organization objectives, teaching strategies, and assessment methods in OBE.

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LIST OF ABBREVIATIONS

OBE	**-**	**Outcome-Based Education**
CLO	**-**	**Course Learning Outcome**
PLO	**-**	**Program Learning Outcome**
PEO	**-**	**Program Educational Objective**
GPA	**-**	**Grade Point Average**
STA	**-**	**Software Technology and Application**
STEM	**-**	**Science, Technology, Engineering, and Mathematics**
PS	**-**	**Practical Skills**
LC	**-**	**Learning Capacity**

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First of all, I wish to express my gratitude and deep appreciation to Almighty Allah, who made this study possible and successful. This study would not be accomplished unless the honest espousal that was extended from several sources for which I would like to express my sincere thankfulness and gratitude. Yet, there were significant contributors for my attained success and I cannot forget their input, especially my research supervisors, Dr. Nargis Fatima and Co-supervisor Dr. Sumaira Nazir, who did not leave any stone unturned to guide me during my research journey.

I shall also acknowledge the extended assistance from the administrations of Department of Software Engineering who supported me all through my research experience and simplified the challenges I faced. For all whom I did not mention but I shall not neglect their significant contribution, thanks for everything.

DEDICATION

This thesis is dedicated to my Teacher and Parents, whose boundless love, encouragement, and sacrifices have been the cornerstone of my academic journey. Their unwavering support and belief in me have provided the foundation for all my accomplishments.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This Chapter provides the introduction of Outcome-Based Education. In addition, comparison of OBE with the traditional education system. The background of the proposed research study shows the lack of research on measuring students' practical skills and learning capacity. This inspires to analyse the effectiveness of Outcome Based Education (OBE) on student's practical skills and learning capacity. Furthermore, the research problem, aim of the research, and scope of research are presented along with the research questions.

1.2 Research Background

Students play an important role in the development of a country in various ways from skill development to entrepreneurship and innovation [1]. This digital skill can be measured through a student's performance. The student's performance refers to the attainment of both short-term and long-term educational objectives [2]. However, educational institute use different method to measure student's performance and progress[1], [3].

Early prediction of a student's performance helps teachers to identify students who are weak in study and give them the opportunity to perform well. A variety of strategies, including student counseling, tracking performance and creating intelligent tutoring programs are effective strategies [4]. According to a recent comprehensive analysis, the reviewed literature concentrated on student grades and GPAs to predict students' performance [5].

Students gain practical experience, such as building software applications, developing hardware prototypes, or simulating systems, which helps them enhance their professional careers [6]. OBE promotes a continuous cycle of feedback and improvement based on the

evaluation of student performance in achieving defined outcomes. This adaptability is particularly important in fields like computing and engineering, where technology and industry requirements evolve rapidly. Programs can quickly adapt to changing technological landscapes by revising learning outcomes and incorporating emerging trends, such as artificial intelligence, data science, or sustainable engineering practices [7].In the computing and engineering domains, Outcome-Based Education helps produce graduates who are highly skilled, industry-ready, and capable of solving complex, real-world problems. By focusing on clear learning outcomes, practical experience, and continuous feedback, OBE prepares students to meet the evolving challenges of these rapidly advancing fields [8].

The learning outcomes are more important than assessing students' academic achievement. Furthermore, Higher Education uses the learning outcomes as the foundation for evaluating the standard of curricula [9]. The Higher education set standards for both students and instructors, evaluating programs and courses. The novel educational method known as "Outcome-Based Education" (OBE) is establishing precise, quantifiable outcomes that students are expected at the completion of a course and program [10].

The main objective of OBE is to ensure that learners have the fundamental knowledge and skills needed for success in the field. The fundamental component of OBE includes Program Learning Outcome (PLO), Course Learning Outcome (CLO), and Program Educational Objectives [11].

In the early nineteenth century, no country placed attention on improvement in education [12]. There were very little funds spent on training and professional development[13]. But in the twenty-first century, this pattern started to change as science and technology came together to produce advanced equipment and more sophisticated engineering techniques [14]. Nowadays, a country’s prosperity depends on the level of education and productivity of its people [15].

Several countries are switching from traditional education to outcome-based education (OBE) because traditional education or teacher-centered learning is insufficient for the field of technology [16]. Compared to the traditional education system, 21 century teachers want their students to show specific learning outcomes at the end of the learning experience [17].

In Outcome-Based Education, students are involved in field work like internship, workshop, project-based learning and case studies [15]. In OBE, the student completes the course's objectives, which are linked to the program learning outcomes. Additionally, Students

of today's generation demand an education that places a strong emphasis on future jobs rather than just developing theory-based knowledge [18].

Implementing the OBE with assessment is complicated for educators because traditional assessment is related to GPA and final scores but OBE involves active learning techniques that enhance student's learning process [19]. In OBE, teaching activities are well organized, planned and continuously improved. All countries around the world struggle to maintain the quality of education by adopting OBE in their institution[20],[21].

The OBE system shows a variety of benefits. For instance, OBE is well-explained in the learning objectives related to the course material. Adaptability in OBE gives teachers the freedom to choose from a variety of teaching-learning strategies, allowing them to present lessons an interactive way. Teaching strategies and activities carefully organize, schedule, and modify over time to achieve the desired results. After finishing the course, students have a clear understanding of the objectives and expected results [22].

Additionally, the OBE teacher encourages students to actively participate in class with modern teaching strategies like constructivism, active learning, student-centered learning, and discovery learning. It makes sure that educational institutions can easily achieve their specified objectives because all teaching and learning activities are clearly stated in the curriculum [23].

All of the above studies emphasize the implementation of OBE in different disciplines and comparison between traditional and OBE. However, there is a lack of studies that show that OBE can contribute to enhancing the practical skills and learning capacity of students.

1.3 Problem Statement

The goal of education has shifted from traditional education to OBE in knowledge acquisition to the development of practical skills and the learning capacity. However, there are no studies on the investigation of students learning capacity and practical skills in OBE [19].

1.4 Research Question

RQ: How to measure attainment of students' learning capacity and practical skills in OBE?

1.5 Research Objective

RO: To measure attainment of students' learning capacity and practical skills in OBE.

1.6 Scope of Research Work

The scope of the research study is to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and their learning capacity. The targeted area of the research was OBE and its effect on the engineering and computing domain. To achieve the goal, this study used the survey method. Total of 140 respondents provided their response. The respondents of the survey were employers of OBE graduates.

1.7 Contribution and Significance

This study helps practitioners to evaluate OBE impact on the development of students' learning capacity and practical skills. This study helped to highlight important of OBE for measuring students learning capacity and practical skills. This study provided significant contribution in the field of Engineering and Computing education by providing the better understanding of OBE. The findings of this study can be helpful in the advancement of outcome-based education.

1.8 Thesis Organization

Chapter 1 provides details of OBE and background of research. It also outlines the motivation, goals, scope and contribution of the thesis. Chapter 2 provides the details of OBE, components of OBE and also highlights the relationship between OBE. It also provides the

details of existing studies and gap analysis. Chapter 3 provides methodology that is used in the thesis. Chapter 4 provides the finding of pilot test and survey results. Chapter 5 summarizes the research conclusion, contribution, limitation and future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the previous chapter, the brief introduction of the research thesis was discussed. Also, the research problem, research objective, and scope of research presented along with the research questions. This chapter OBE provides the details of OBE, components of OBE and highlights the relationship between OBE. It also provides the details of existing studies and the gap analysis.

2.2 Outcome- Based Education

Numerous strategies based on theoretical frameworks have been developed to improve education in Higher Education over the past two decades [24]. Outcome-Based Education (OBE) aims to establish specific learning objectives that students are expected to achieve by the end of their educational journey. OBE places more emphasis on the learning goals than on conventional techniques like lectures and exams[25].

William Spady developed outcome-based education (OBE) in the 1990s that changed the formal education system. In contrast to conventional teaching methods, OBE focuses on achieving specific objectives and demonstrating educational skills at the end of their educational experiences [26]. Outcome-Based Education is applied across the different educational levels, from primary schools to Higher Education Institutions [27].

In Outcome-Based Education, all students have basic knowledge and skills necessary for success in the field. Arranging and managing the institute in a way that makes it easier for all students to achieve and maximize their outcome[28].

In OBE, outcomes are categorized into different levels [29] such as Program Outcomes (POs) that refers the skills and knowledge gain that students completing general programs and Course Outcomes (COs) that refers to the skills and knowledge that students gain after finishing a particular course[30]**.**

OBE applied to undergraduate programs to ensure that students gain the fundamental knowledge required for success in the professional career. Today Institutions produce graduates that are proficient in academia and also well-equipped to handle the challenges. OBE is a useful framework for increasing the standard and accessibility of undergraduate education [31].

2.3 Components of Outcome-based Education

Outcome-based education (OBE) focuses on key components that differentiate it from traditional educational approaches. It includes Course Learning Outcome (CLO), Program Learning Outcome (PLO), Program Educational Objective (PEO) and Assessment Techniques. Figure 2.1: Outcome-based Education components show the components of OBE. The components are discussed in the upcoming subsection.

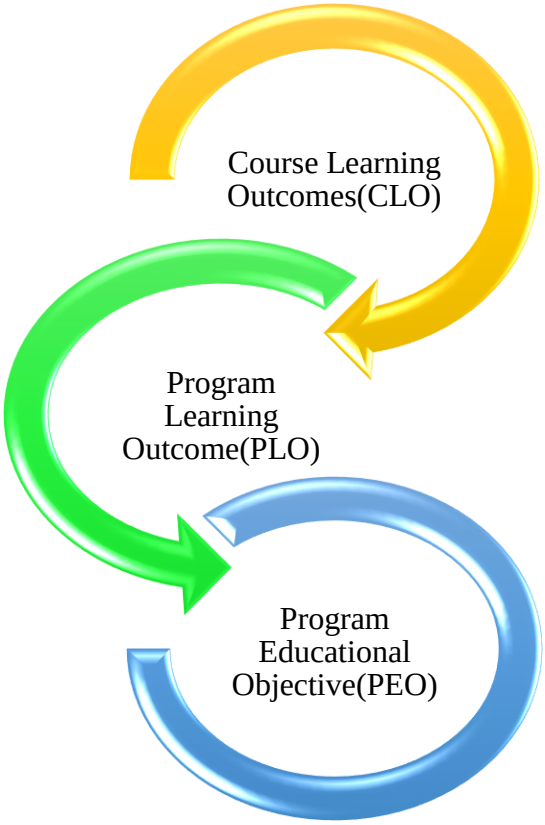

Figure 2.1: Outcome-based Education components

2.3.1 Course Learning Outcome (CLO)

Course Learning Outcome provides more emphasis on the learning process that students gain from the course. It specifies the well-defined and precise knowledge that students intend to acquire through interaction with the course content [32]. CLOs are dependent on the faculty that are responsible for delivering the course. Usually, the entire outcomes of the program are integrated with the Course Learning Outcomes (CLOs) [33]. This makes it possible to evaluate student performance and guarantees that the outcome may be assessed [34].

2.3.2 Program Learning Outcomes (PLO)

Program Learning Outcomes describe the skills and knowledge that students gain after completing a full program. The CLO aligns with the PLO and provides a comprehensive understanding of OBE. PLO designed according to professional requirements and industry standards [35].

An important factor in assessing OBE is the accomplishment of PLO and PEO. Accomplishment PEO and PLO helps to improve the institute's vision and mission. Different teaching strategies, including seminars, classroom lectures, lab experiments, presentation and projects, are used to achieve PLO. CLOs are integrated into each course's structure, and each CLO is linked with an appropriate PLO [36]. Thus, Continuous internal assessment can be used to assess each students' performance in terms of both CLOs and PLOs [37].

The overall accomplishment of the learning process can be calculated by analyzing the Direct and Indirect assessment. The direct assessments method includes Quizzes, assignments and presentations. On the other side, indirect methods of assessment include Alumni surveys, Employer surveys, Curriculum feedback[37]. The detail of assessment techniques is given in section 2.4.

2.3.3 Program Education Objective (PEOs)

The PEOs described broad statements that show the detail of program objectives. It also prepares the graduates for professional achievements [38]. PEO are designed by stakeholder which includes Employer, University, Professional Associations and Authorities [39].

2.4 The Assessments Techniques in Outcome Based Education

Assessment technique is an instrument that is used to assess students' performance. Through the assessment techniques teachers assess the progress of students in order to find whether they met the CLO and PLO. Researchers have investigated the different types of assessment that motivate students to improve their education [40].

Assessments techniques evaluate students' ability by applying their knowledge into real world problems. These assessments use different methods and are also connected to course learning objectives. These include summative, formative, authentic and self-assessments. E-assessments are the different types of assessment techniques [41], [42].

Regular evaluation techniques called formative assessments. These assessments include assignments, projects, presentations, quizzes and unofficial observations. On the other hand, summative assessments, including final exams and projects that are conducted at the end of a course [43].

Authentic assessments are especially useful for testing higher-order cognitive skills because they require students to apply their knowledge in real-world situations [44].

A self-assessment is a systematic procedure in which students analyze their own abilities and performance. It is frequently applied in a variety of applications including academic assessments, work performance assessments, and personal improvement. On the other hand, online evaluations can contribute to practical improvements [45].

To accurately assess students' practical skills and cognitive understanding, diverse assessment techniques are needed. Therefore, it is important to design an assessment method that evaluates the abilities of students as well as their understanding [46]. The Outcome-Based Education (OBE) methodology offers a creative assessment method that enhances student's learning [47].

2.5 Relationship between CLO, PLO and PEO

Course Learning Outcome (CLO) and Program Learning Outcome (PLO) work together to achieve the Program Education Objective. Each course within a program has CLOs that ensure the achievement of all relevant PLOs. Students must have necessary skills and

knowledge to achieve the Program Educational Objective. They work together to create a systematic framework that guarantees that learning outcomes meet Program Educational Objectives [48]. CLOs are designed for each course. Each CLO is mapped to program learning outcomes. Likewise, each PLO is mapped to PEO.

2.6 Benefit of Outcome-Based Education

The goal of OBE is to improve the standard and performance of education by emphasizing well-defined learning outcomes, co-ordinating educational activities with stakeholders and enhancing teaching and learning processes. These advantages help to produce a total that makes valuable contributions to society [49].

There are various ways to improve the educational system. The traditional way is to produce new knowledge that led to innovations. The majority of innovations depend on the application and integration of already-existing knowledge[50]. Educational innovations possible by creativity in the workplace, integrate new skills in curriculum as instructional tools[51].

In Outcome Based Education, students are encouraged to reflect on their own learning in order to advance their skill. It is necessary to develops new and reliable techniques in order to increase students' active participation in learning outcomes[52]. In OBE, instructors focus on students' innovative skills and also implementation of those skills and knowledge [53].

Educators worldwide understand that learning extends beyond the simple transmission of knowledge. The main advantages of Outcome-Based Education (OBE) include the establishment of more structured, innovative, and adaptable teaching approaches [54].

2.7 Bloom's Taxonomy

Bloom's Taxonomy is used to categorize different stages of cognitive learning. It can be effectively used to promote the attainment of COs and POs. The alignment of teaching strategies and assessment techniques in this taxonomy ensure that students receive diverse education [55]. The bloom’s taxonomy is divided into domains such as Cognitive, Psychomotor and affective. The domains are presented in Figure 2.2: Bloom's Taxonomy Domains.

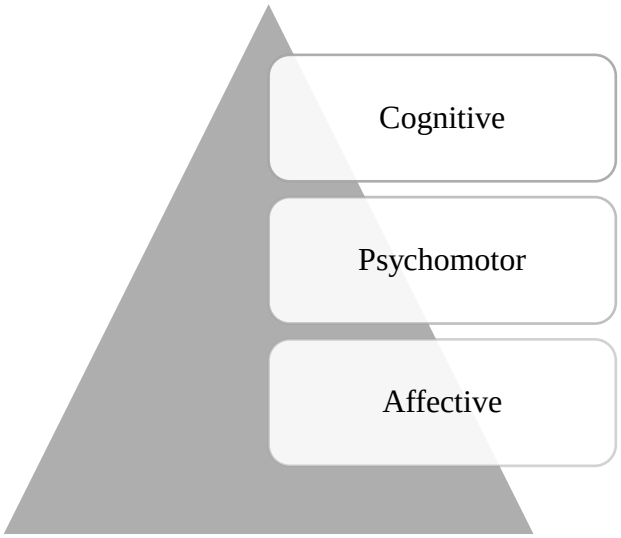

Figure 2.2: Bloom's Taxonomy Domains

Table 2.1 shows the Cognitive domain level. Six different categories fall under the cognitive domain. Cognitive domain ranging from basic recognition to advanced problem skills. Affective domain refers to learning about attitudes, feelings, and emotions. The psychomotor domain is concerned with learning through movement ranging from basic movements to complex physical skills [56]. These categories specify the methods used within learning content. From basic to advanced learning skills, each of the six categories creates a hierarchy [57].

Table 2.1: Cognitive Domain [56]

Sr. No	Level	Description
6	Create	Assembling all components to create an innovative or a unique product. The categories of Creating, Planning, and Developing are included in this category
5	Evaluate	Make judgments about the facts in order to present and defend viewpoints. The reviewing and criticizing subcategories are included in this category
4	Analyse	Analyse and divide material into sections. Determine the cause and motivation. The subcategories of Differentiating, Organizing, and Attributing are contained within this group.
3	Apply	Executing or applying a process in a particular circumstance. Subcategories such as Conducting and Designing are included in this category.
2	Understanding	Interpreting written, graphic, and educational materials to determine their meaning. The subsections are included in this

		category are translating, demonstrating, Classifying, Summarizing, Comparing, and Explaining.
1	Remembering	Obtaining appropriate data from long-term memory. The subcategories of Remembering are Identifying and Recalling.

The psychomotor domain is concerned with learning through movement ranging from basic movements to complex physical skills. Table 2.2 show the psychomotor domain of bloom taxonomy. There are 7 level of psychomotor that include perception, set, guided response, Mechanism, Complex Overt Response, Adaption and organization.

Table 2.2: Psychomotor Domain [55]

Sr. No	Level	Description
1	Perception	The ability to use sensory cues to guide motor activity. This involves recognizing and interpreting stimuli to make appropriate responses.
2	Set	Readiness to act, which involves mental, physical, and emotional readiness to perform a task.
3	Guided Response	The early stages of learning a new skill, where responses are performed with guidance or assistance.
4	Mechanism	Intermediate stage where the skill becomes more refined and automatic.
5	Complex Overt Response	High level of skill execution where tasks are performed with ease and efficiency.
6	Adaption	The ability to modify and adapt skills to different situations.
7	Origination	Creating new and innovative approaches or techniques.

Affective domain refers to learning about attitudes, feelings, and emotions. Table 2.3 shows the affective domain of bloom taxonomy. The level includes receiving, responding, valuing, organizing and characteristics.

Table 2.3: Affective Domain [55]

Sr. No	Level	Description
1	Receiving	The initial stage where learners are simply aware of or attentive to the information.

2	Responding	The stage where learners actively participate and respond to the information.
3	Valuing	At this level, learners begin to attach value to the information and start to internalize it.
4	Organizing	This stage involves integrating new values and attitudes into one's existing value system.
5	Characterizing	The highest level where values and attitudes are deeply ingrained and consistently guide behaviour.

2.8 Existing Studies in Outcome Based Education

Table 2.4 shows that the researcher has provided their effort in the context of OBE from various aspects. However, there is a lack of studies on the investigation of student's learning capacity and practical skills in OBE in a real environment. Table 2.5 show the gap analysis.

Table 2.4: Existing studies in OBE

Sr. No	Title of paper	Author and Years	Finding	Limitation	Methodology	Reference
1	Outcomes-based Approach in Engineering Education for Special Education Need Students: Psychology and Rehabilitation Elements	Mohd Norazmi 2023	There is need for training in curriculum design, assessment procedures, and the development of learning outcomes for maximize the effectiveness of the OBE approach.	Paper not measures the attainment of students and not performed field study.	Survey	[58]
2	An application of text mining techniques and outcome-based education: student recruitment system	K Thirumoorthy 2023	This structured approach improves the recruitment process by identify students that need necessary skills and knowledge.	The paper mentions plan to cluster students with similar interests, it does not provide a comprehensive methodology for how this clustering will be conducted. This absence may limit the effectiveness of personalized educational recommendations.	The methodology of the paper involves several key components aimed at developing a student recruitment system based on outcome-based education (OBE).	[59]

3	Switching to Outcome-Based Education (OBE) System, a Paradigm Shift in Engineering Education	Muhammad Zunair 2022	The OBE system is comparatively better than traditional teaching methods in engineering education. In OBE, students agreed to adopt a technical approach, practical work, and future career skill development.	There is a lack of detailed analysis and empirical evidence specifically focused on its impact on student learning outcomes and teaching effectiveness at institutions like Riphah International University.	Survey method	[60]
4	Outcome Based Education (OBE): Defining the Process and Practice for Engineering Education	Mm Mahbubul Syeed et al 2022	The OBE implementation in offers guidance to academic stakeholders on how to adopt an effective OBE framework.	The paper does not provide a detailed description of the methodology adopted for the study, which may make it difficult for to validate the results.	The methodology of the paper is structured around the development and implementation of a comprehensive Outcome Based Education (OBE) framework for tertiary level engineering programs	[61]
5	Implementing outcome-based education and student-centered learning in Afghan public universities: the current practices and challenges	Rahmatullah Katawazai 2021	The need for comprehensive training, institutional support, and assessment practices to enhance the implementation of OBE in the Afghan higher education context.	Some lecturers expressed a lack of knowledge about OBE which indicates a gap in awareness and training regarding OBE among faculty members. Additionally, the institutions have not yet designed their Program Outcomes (POs), which hinders the effective implementation of OBE.	Mixed method	[62]
6	A Review on Outcome Based Education and Factors That Impact Student Learning Outcomes in Tertiary Education System	Hafiz Muhmmad Asim 2021	Five important factors identified that impact on student learning outcomes.	Limited number of studies included in the review that lack generalizability across all higher education institutions	Systemic review	[63]
7	Impact Evaluations of Engineering Programs Using ABET Student Outcomes	Wajid Hussain 2021	It focuses on a non-experimental approach, utilizing regression methods and rubrics without explicit comparison groups, which may affect the robustness of the findings	The study not measure the attainment of student and not perform field study.	Non-Experimental Approach	[64]

8	Impact of Outcome-Based Education on Software Engineering Teaching: a Case Study	Hong-Ning Dai 2017	OBE can enhance problem-solving capabilities in software design and positive impact on the overall curriculum in IT education.	The research focuses on a specific set of courses within the Software Technology and Application (STA) program. The findings may not be generalizable to all IT-related programs or other disciplines, limiting the broader applicability of the results.	Case study	[65]
9	An outcome-based assessment process for accrediting computing programs	Haidar M. Harmanani 2016	OBE is well-structured, faculty-engaged, and data-driven approach that significantly improve the accreditation process for computing programs.	The paper does not explicitly address how the outcome-based assessment process can accommodate diverse student and varying learning styles.	The methodology focuses on implementing an outcome-based assessment framework	[66]
10	Computer Based Teaching Methodology for Outcome-Based Engineering Education	M.Rajendra Prasad et al 2016	Computer Based Teaching Methodology is a valuable approach, fostering a more interactive and practical learning environment that prepares students for industry challenges.	The methodology may not include a robust mechanism for continuous feedback from students regarding their learning experiences, which is essential for iterative improvement of the teaching approach.	Computer Based Teaching Methodology (CBTM)	[67]

The researcher has provided their effort in the context of OBE in the Engineering and Computing domain. However, there is a lack of studies on the investigation of student's learning capacity and practical skills in OBE.

For instance, Mohd Norazmi 2023 explores the influence of Outcome-Based Education (OBE) in engineering education, particularly for students with special education needs. The study aims to assess how OBE can enhance the teaching and learning experience by shifting from a teacher-centered to a student-centered approach. To achieve objective survey methodology was used. The target audience was faculty members and students. Additional professional training and assistance required to successfully adopt Outcome-Based Education (OBE) in engineering programs [58].

Likewise, K Thirumoorthy 2023 proposed a new student recruitment system that identifies the best students based on their attainment. The methodology of the paper involves a structured approach to develop the proposed student recruitment system based on course outcome attainment. The proposed student recruitment system effectively identifies the best

students based on their attainment of course outcomes (CO). The system was tested only in a single institution (Mepco Schlenk Engineering College), which raises concerns about the generalizability of the findings to other educational contexts or disciplines [59].

Moreover, Muhammad Zunair 2022 compares the effectiveness of the Outcome-Based Education (OBE) system with traditional teaching methods in engineering education, specifically at Riphah International University. The paper uses a questionnaire survey to collect data from two groups of students those who took a course under the OBE system and those who passed the subject with a traditional engineering educational system (non-OBE). Students who took courses under the OBE system showed satisfaction over obtaining an analytical approach and developing problem-solving expertise. The study only focuses on engineering education at Riphah International University, which limits its generalizability to other educational institutions and fields of study [60].

Meanwhile, MM Mahbubul syeed et al 2022 define the process and practice of Outcome Based Education (OBE) in engineering education, and to provide a step-by-step process for developing a program curriculum. The study describes the structured approach for developing and implementing a comprehensive Outcome Based Education (OBE) framework. The case study is conducted in a single department of a specific university, which may limit the generalizability of the findings to other academic institutions. Additionally, the paper does not provide a detailed description of the methodology adopted for the study, which makes it difficult to validate the results [61].

Likewise, Rahmatullah Katawazai 2021 explores the challenges and opportunities of implementing OBE. A mixed-method was utilized to collect both quantitative and qualitative data. Some lecturers expressed a lack of knowledge about OBE which indicates a gap in awareness and training regarding OBE among faculty members. Additionally, the institutions have not yet designed their Program Outcomes (POs), which affect the implementation of OBE [62].

Moreover, Hafiz Muhmmad Asim 2021 examines the tertiary education system in Pakistan and transitions from a teacher-centered approach to an Outcome Based Education (OBE) system. It aims to identify the key factors that influence student learning outcomes. The paper utilized a review methodology. Five important factors identified that impact on student learning outcomes. Factors include Assessment Strategies, Learning Objectives based on level of complexity, Student preferred learning styles, English language competency and employer

requirements. Only seven studies included in the review that lack generalizability across all Higher Education institutions [63].

Additionally, Wajid Hussain 2021 examines the benefits and limitations of implementing an OBE model in engineering programs. The methodology of the paper involves a non-experimental approach that utilizes regression analyses. It focuses on a non-experimental approach for impact evaluations, utilizing regression methods and rubrics without explicit comparison groups, which may affect the robustness of the findings [64].

On the other hand, Hong-Ning Dai investigated the effects of Outcome-Based Education (OBE) on student learning outcomes within a software engineering program. Case study conducted to investigate the effect of OBE. OBE can enhance problem-solving capabilities in software design and show a positive impact on the overall curriculum in IT education. The research focuses on a specific set of courses within the Software Technology and Application (STA) program. The findings may not be generalizable to all IT-related programs or other disciplines, limiting the broader applicability of the results. Small sample size may not adequately represent the larger student population, potentially leading to biased conclusions [65].

Likewise, Haidar M. Harmanani contributed to the advancement in computing education through a comprehensive approach to assessment. This study presents a framework for outcome-based assessment, it may not address the specific challenges faced by different types of computing programs (e.g., software engineering, cybersecurity, data science) [66].

Additionally, M.Rajendra Prasad et al enhance the quality of engineering education through innovative teaching methodologies that prepare students for the industry. Computer Based Teaching Methodology is a valuable approach in engineering education, fostering a more interactive and practical learning environment that prepares students for industry challenges. The methodology may not include a robust mechanism for continuous feedback from students regarding their learning experiences, which is essential for iterative improvement of the teaching approach [67].

2.9 Gap Analysis

The Table 2.5 shows the number of studies performed in the context of OBE in the Engineering and Computing domain. However, there is lack of studies on the investigation of student’s learning capacity and practical skills in OBE in a real environment. The is aim of this

study is to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and the learning capacity. Effective teaching methods help students to develop their practical skills and measure their learning capacity. Some innovative method includes hands on activities like online tests, real world tasks, models, or practical tool uses to enhance the student's practical skills and learning capacity [68].

Research work in which learners put their academic knowledge in an actual situation also improves the learning capacity of students. This is especially significant in the STEM fields—Science, Technology, Engineering, and Mathematics. Internships are also measuring the practical skills that encourage students to experience real-world employment. This helps learners to apply academic knowledge into professional practical experience. Combing education knowledge with projects helps students to exchange ideas, take responsibilities, and share other's practical experiences. This integration of technology is also boosting the skills [68]. The case analysis a specialist software, machinery and Mentoring program allows students to work with experienced experts [69].

Table 2.5: Gap Analysis

Sr. No	Title of paper	Author	Engineering/ Computing Domain	Field Study	Measure Attainment	Target Audience	Journal/ Conference
1	Outcomes-based Approach in Engineering Education for Special Education Need Students: Psychology and Rehabilitation Elements	Mohd Norazmi 2023	✓	×	×	Students	Journal for Re Attach Therapy and Developmental Diversities.
2	An application of text mining techniques and outcome-based education: student recruitment system	K Thirumoorthy 2023	✓	×	×	Students/ Teachers	Journal of Ambient Intelligence and Humanized Computing
3	Switching to Outcome-Based Education (OBE) System, a	Muhammad Zunair 2022	✓	×	×	Students	IEEE Transactions on Education

	Paradigm Shift in Engineering Education						
4	Outcome Based Education (OBE): Defining the Process and Practice for Engineering Education	MM Mahbubul Syeed et al 2022	✓	×	×	Students	IEEE Access
5	Implementing outcome-based education and student-centered learning in Afghan public universities: the current practices and challenges	Rahmatullah Katawazai 2021	×	×	×	Teachers	Heliyon
6	A Review on Outcome Based Education and Factors That Impact Student Learning Outcomes in Tertiary Education System	Hafiz Muhmmad Asim 2021	×	×	×	Students	International Education Studies
7	Impact Evaluations of Engineering Programs Using ABET Student Outcomes	Wajid Hussain 2021	✓	×	×	Students/Teachers	IEEE Access
8	Impact of Outcome-Based Education on Software Engineering Teaching: a Case Study	Hong-Ning Dai 2017	✓	×	✓	Students/Teachers	IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE
9	An outcome-based assessment process for	Haidar M. Harmanani 2016	✓	×	×	Teachers	European Journal of Engineering Education

	Accrediting computing programs						
10	Computer Based Teaching Methodology for Outcome-Based Engineering Education	M.Rajendra Prasad et al 2016	✓	×	×	Students/Teachers	International Conference on Advanced Computing

2.10 Summary

This Chapter provides details of OBE, existing studies in context of OBE, particularly from Engineering and Computing domain. The chapter also provides the details of gap analysis in the existing literature.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The Chapter 2 provides the details about the background of OBE, components of OBE like CLO, PLO and PEO and the benefit of OBE. The Chapter 3 provides the details about the methodology adopted in the research thesis.

3.2 Research Design

Research can be conducted by using a variety of approaches, depending on whether the study is descriptive or explanatory [70]. Three types of methodologies are used in research, quantitative, qualitative and mixed methods. In this study, a survey approach (quantitative research) was adopted to investigate student learning capacity and student practical skill of OBE graduates. The respondents of the survey are employers of OBE graduates that work in the software industry.

The survey steps that are followed include identification of research objective, identify and characterize target audience, design sampling plan, questionnaire design, pilot testing, distribution of questionnaire, analysis.

Quantitative approaches concentrated on quantifiable data that show comprehension information [71]. Qualitative data provide an extensive overview of the data. Mixed methodology combining quantitative and qualitative methods. Qualitative approaches can be used for data collecting data while quantitative methods can be utilized for data analysis. Mixed methodology refers to merging the two approaches [72].

Survey is a popular technique for data gathering. It facilitates decision-making by solving challenging problems and providing solutions [73]. This method is directly related to questionnaires because the majority of the data are obtained through the questionnaires and the validity of the questionnaire is an important factor. The survey questionnaire can be shared

using various platforms such as via email or shared on LinkedIn, along with instructions to complete it.

Additional methods include field work, training, action research, experiments in laboratories, documentary research, and detailed interviews [74].When survey done correctly, it enables you to draw generalizations of a large population. For implementation of the survey, it is necessary to follow standardized format. Failure to fulfill these standards may result in misleading outcomes [74].

Figure 3.1 illustrate the steps involves in conducting survey. The primary goal of this study is to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and their learning capacity. This study followed the Kasunic guideline [75], because most of researchers used to conduct successful surveys in the field of software engineering. The objective of this study is to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and their learning capacity.

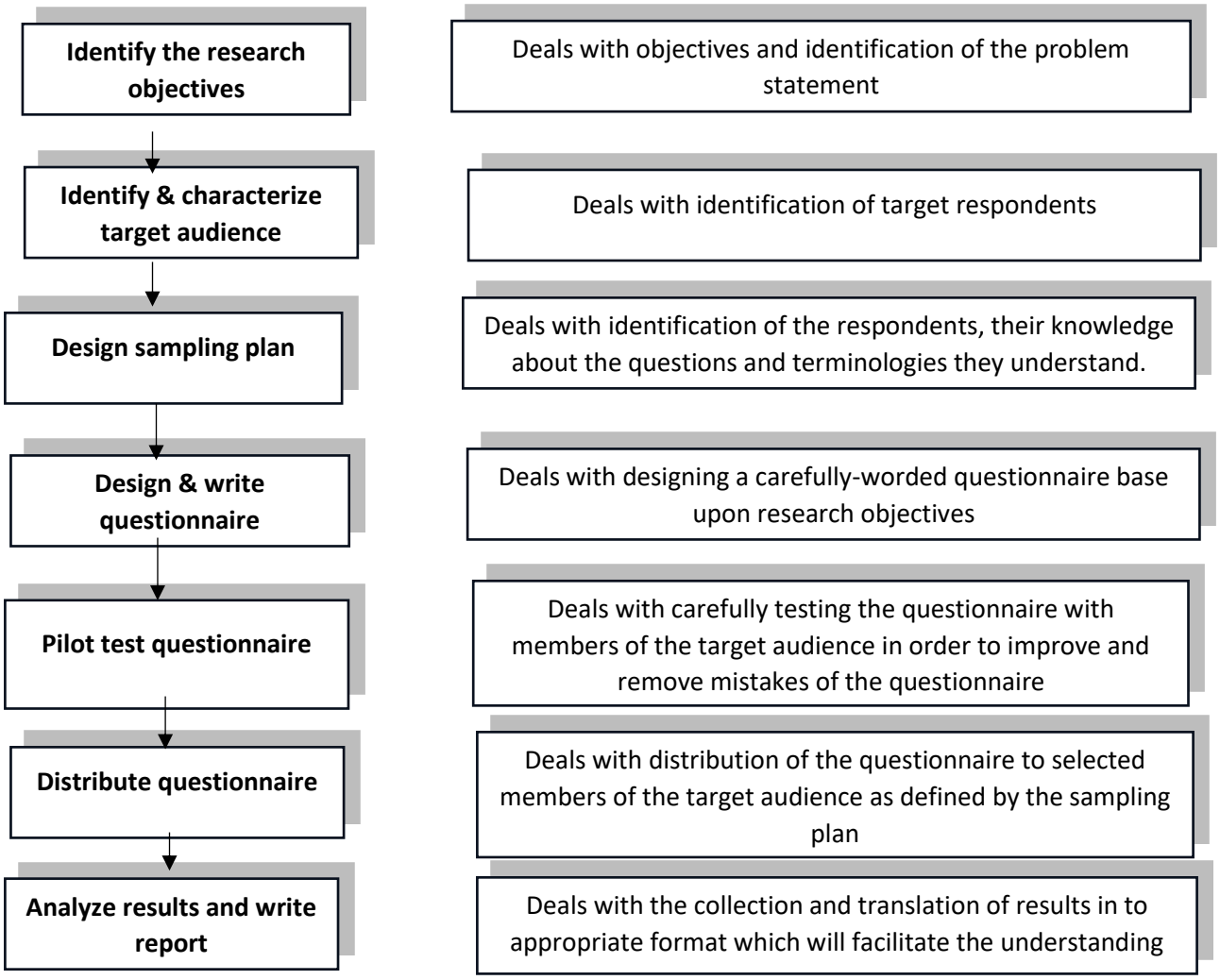

Figure 3.1: Steps for survey conduction [75]

3.3 The Survey Research Process

This section provides the steps followed in this research to conduct survey study. The steps are discussed in subsection.

3.3.1 Identify Research Objective

The initial step of the survey is to identify the research objective by understanding the problem statement. This helps to specify participants in a survey. The objective of this research is to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and their learning capacity. Before conducting a survey, having a well-defined research objective is of most importance. It assists in defining the survey's scope by identifying the target respondents and the specific questions that need to be posed to them.

3.3.2 Identify and Characterize the Targeted Audience

During this stage, the specific population that serves as the foundation for the survey research has been selected. In this step, determine the survey target audience. The audience is chosen using a research perspective, considering the goals of the study as well as the audience that provides the information related to the research objective [75]. In this study, first collects OBE graduates' data from OBE based universities in the form of excel sheets and word forms and then identifies their employers. In this study, the target audience are employers of OBE graduates.

3.3.3 Designing the Sampling Plan

In this step, designing a sampling plan by using different sampling techniques. Sampling is a process to gather information or data from a large population. Several formulas can be used to calculate the sample size. The desired precision, population size, and desired confidence level all influence the sample size[76]. A larger sample size reduces the possibility of biases in the results. Sample size shows the number of responses rather than the number of distributed questionnaires [77].

Therefore, utilizing significant samples and using the right sampling method is helpful for validation[78]. A 100% response rate is extremely difficult for researchers to get for a variety of reasons, including respondent incapacity, refusal, ineligibility, or respondent availability [79].In this study, sample size calculated by following Slovin's Formula and Krejci and morgan table [80], [81].

$$n = \frac{N}{1+Ne^2}$$

- where: n: Sample size needed
- N: Population
- e: Acceptable margin of error

$$n = \frac{220}{1+220(0.05)^2}$$

The sample size for the survey was 140 from the entire population of 220. Responses are collected from employers of OBE graduates. There is main two techniques for sampling used in surveys including probability and non-probability [82]. Figure 3.2: Sampling Techniques show the sampling techniques that use in mostly research.

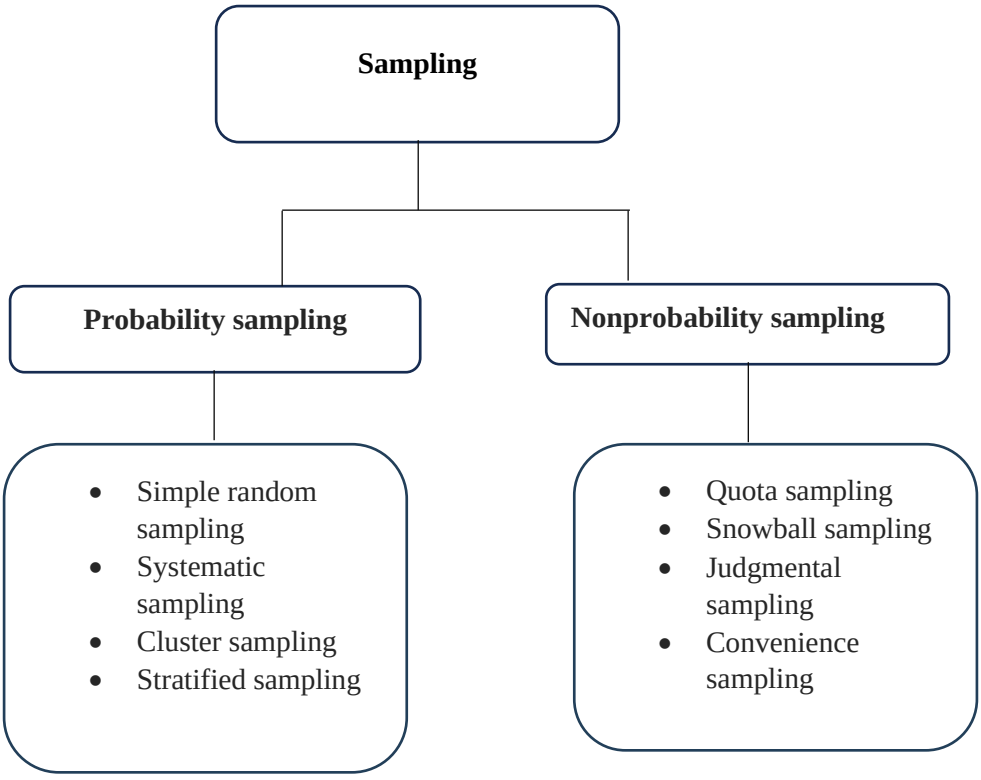

Figure 3.2: Sampling Techniques

3.3.3.1Probability Sampling

Probability refers to "chance." Probability sampling in surveys makes sure that each person in the population has an equal chance to participate in the survey. It is nearly bias-free, effective technique and less chance of sampling error [83].

In surveys, simple random sampling is a widely used sampling technique. In which individuals of a population are randomly selected in research, simple random sampling is used for extremely homogeneous populations [84].

Systematic random sampling involves selecting participants from a population at specified times after randomly selected participants. It organized the sequence and random approach ensures that every item in the population has an equal chance of selection [84].

Stratified sampling involves dividing the population into smaller groups based on homogeneous characteristics that groups are called strata. After that, samples from each group are selected randomly. This ensures that strata represent the whole population [85].

In statistics, cluster sampling is the process of dividing the population into groups, or clusters, and then choosing these clusters randomly to represent the total population [85].

3.3.3.2 Non-Probability Sampling

In non-probability sampling, it is impossible to give equal chance to each participant in the survey. It is different from probability sampling and does not entirely represent the population. Non-probability sampling techniques are frequently used when random sampling is either too expensive or unfeasible [86].

In convenience sampling, the researcher selects participants based on their ease of accessibility or familiarity. This approach did not accurately represent the whole population [87] .

Purposive sampling in which researchers selected participants based on specific attributes or criteria relevant to the goals of the study. This approach depends on the experience of the researcher and judgment [87].

In Quota sampling researchers categorize the population into strata, is based on predetermined criteria, and then non-randomly selected individuals [88]

In research, snowball sampling is technique that involves finding new participants by recommended by previous participant. It establishes a chain that gradually increases the sample

size like a snowball [88]. In this study, a probability sampling technique was used. It is nearly bias-free and has less chance of sampling error.

3.3.4 Questionnaire Design

In this step, the questionnaire is designed. Questionnaire is divided into two sections. The first section of the questionnaire contains demographic information such as name, experience, age, gender and role/designation of the respondent. Next section of the questionnaire consists of core factors (engineering knowledge, modern tool usage, ethical, life-long learning, problem analysis, knowledge, design and development, investigation, communication, individual and teamwork, project management and finance) of Washington Accord (engineering professional) and Seoul Accord (computing). It is important to carefully design survey instruments and use language that is understandable by the target audience. The design questionnaire is attached in Appendix A. Table 3.1 illustrates this study used five-item Likert scale to evaluate respondents' opinions.

Table 3.1: Scale defining the Practicality Level

Scale	Score
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

3.3.4.1Validity

Validity shows that a research study accurately measures what it intends to measure [89]. Validity evaluates whether a research or test truly measures the construct. It ensures the reliability and significance of the results. There are different types of validity like face validity, content validity and construct validity [90]. Table 3.2 shows the comments of OBE experts for content validity and action taken.

Table 3.2: Comments for Content Validity

Evaluators	Comments	Action taken
Evaluator 1	Formatting issue.	Changes done on Content validation form.
Evaluator 2	Add Likert scale for response.	Changes done according to instructions.
Evaluator 3	Write PLO in sequence. Use specific words in questionnaire that are written in Seoul accord and Washington accord guideline.	PLO written in sequence. Used specific word that is used in guideline.
Evaluator 4	Questions need to be increased Must add all PLO. Write Yes and No instead of 1 and 0	Changes done according to instructions.
Evaluator 5	Question 8 need to restructures. Question 9 add in PLO 6(The engineer and society) Question 24 and 29 need to be excluded	Question 8 restructures. Question 9 add in PLO 6(The engineer and society) Question 24 and 29 excluded

Table 3.3 shows the profile of Evaluators and their designation. In this study, a content validation form designed to check the validity of the survey question, in which the questions were validated by five OBE experts from different universities like Air University, Bahria University and Riphah International University.

Table 3.3: Profile of Evaluators for Content Validity

Expert's No.	Organization Name	Designation
Evaluator 1	FTTI E-9 Islamabad	Lecturer
Evaluator 2	Bahria University Sector E-8/1 in Islamabad	Lecturer
Evaluator 3	Riphah University Near Hajj complex, I-14 Islamabad	Assistant Professor
Evaluator 4	Air University E-9 Islamabad,	Assistant professor
Evaluator 5	Air University E-9 Islamabad	Assistant professor

3.3.5 Pilot Test Questionnaire

A pilot test is a small-scale, initial test that is conducted before the actual implementation of the survey. It is also referred to as a pretest. The purpose of the pilot test is to find and fix any possible problems with the survey instrument (questionnaire). It helps researchers to make sure that the survey questionnaire is carefully constructed and accurately measures what it is supposed to measure.

This allowed making necessary corrections and modifications in the questionnaire to make sure that respondents understood the questions [91]. 28 respondents participated in the pilot test. After modification in the questions, a questionnaire given to the employer of OBE graduates for pilot testing.

For pilot testing, a survey is distributed through email and also shared on LinkedIn to get response from top management e.g. employer. The majority of the remarks given on the question wording, grammatical error and structure of sentences. According to suggestions and comments, the questionnaire was updated.

3.3.6 Distribution of Questionnaire

In the distribution phase of the questionnaire, finalized questionnaires given to the target audience in order to collect the responses. Initially, the questionnaire was being shared online through LinkedIn Corporation and Emails. The online process took a time, and after that, certain software companies were visited in order to get responses.

3.3.7 Result Analysis

Researchers utilize data analysis to draw conclusions [92] ,[93]. The result analysis of the data collected through questionnaire was done in this phase. The result analysis is discussed in Chapter 4.

3.4 Summary

This chapter provides the detail of survey research methodology that was followed to achieve the study objective. The survey research steps objective, target audience, sampling, questionnaire design, validity, distribution and result analysis are briefly discussed.

CHAPTER 4

FINDING AND DISCUSSION

4.1 Introduction

The Chapter 3 was about the research methodology that was followed in this research. In Chapter 4, finding of pilot test and survey result are presented. The descriptive statistics of the survey is represented in this chapter.

4.2 Finding from Pilot Test

A pilot test or pretest is conducted before the actual implementation of survey. In the pilot test 28 respondents participated in the online survey which included 46.4% females and 53.6% males. The google form was distributed by Email, LinkedIn and some software houses were visited to get survey responses. After some modification in questionnaire wording and statement survey was distributed. Survey consists of two major sections. The section I includes demographic information such as age, gender, team size, experience and designation in Organization.

The section II contains core questions based on 12 PLO from Washington Accord and Seoul Accord such as Engineering Knowledge, Problem Analysis, Design/Development of Solution, Modern tools Usage, The Engineer and Society, Environment and Sustainability, Ethics, Individual and Teamwork, Communication, Project Management and Finance, Lifelong Learning. The PLOs are given in Appendix C.

4.3 Survey Execution

The survey is executed based on the guidelines given by Mark Kasunic [75]. The detailed methodology of survey conduction is discussed in Chapter 3. The research aims to evaluate the practical skills and learning capacity of OBE graduates. The survey question was distributed to the employers of OBE graduates. The questionnaire contains two sections.

The section I was designed to collect profile information of the survey respondents. The section II of the survey questionnaire comprised core questions of learning capacity and

practical skills. Link containing the survey questionnaire was distributed in June 2024 and 140 responses were received. The design questionnaire is attached on Appendix A and profile of employers is given in Appendix B.

4.3.1 Descriptive Statistics of Respondents

Figure 4.1 shows the descriptive statistics of respondents This study provides the descriptive statistics of respondents based on experience, team size, age and designation.

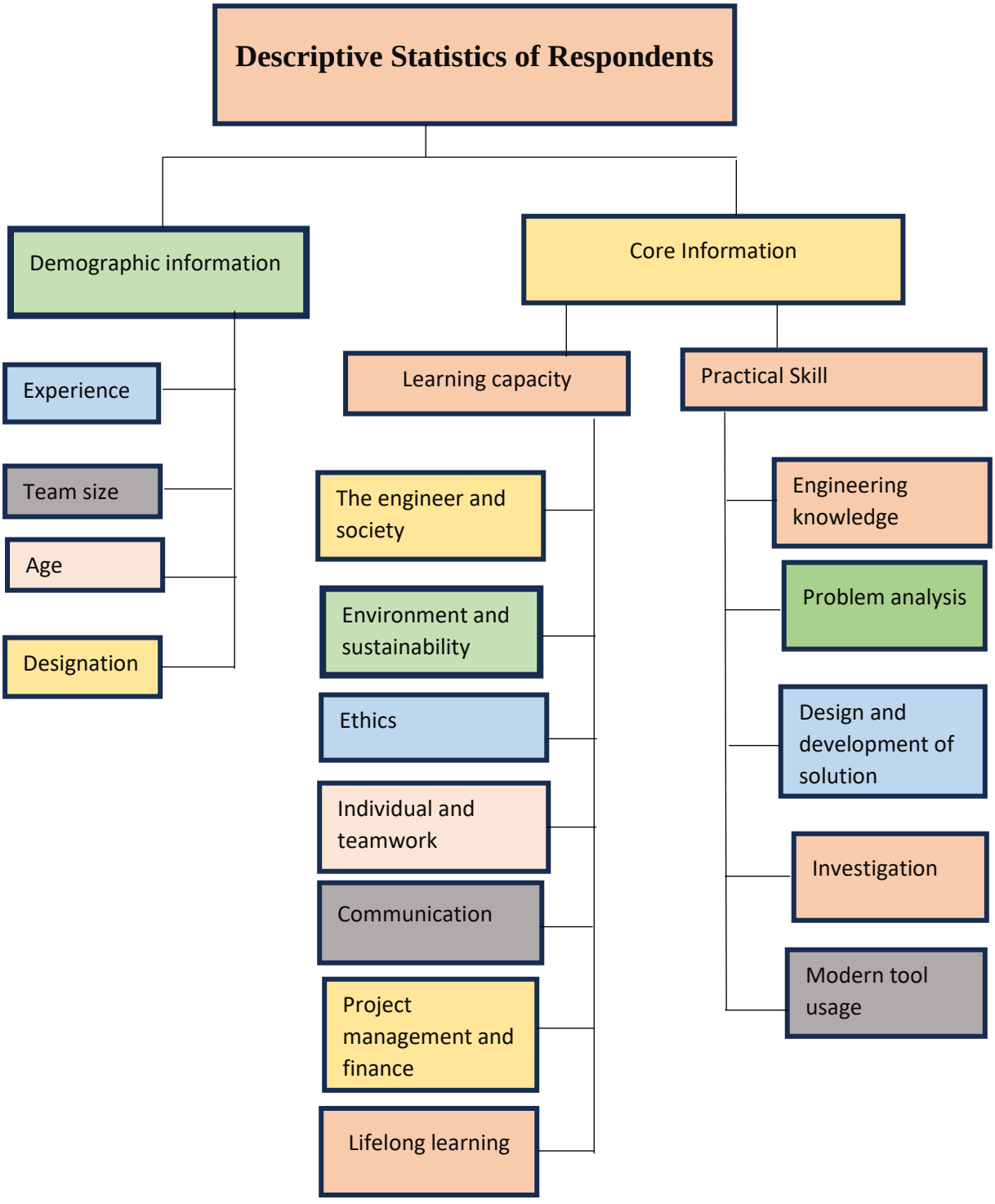

Figure 4.1: Descriptive Statistics of Respondents

4.3.1.1Descriptive Statistics of Respondents Based on Experience

Figure 4.2: Descriptive statistics of respondents based on work Experience of respondents. Total 140 respondents participated in the survey. Out of 140 respondents, 42.9% have 8 to 10 years of work experience, 24.3% have 4 to 7 years of experience, 18.6% have more than 10 years of experience and 14.3% have 0 to 3 years of experience.

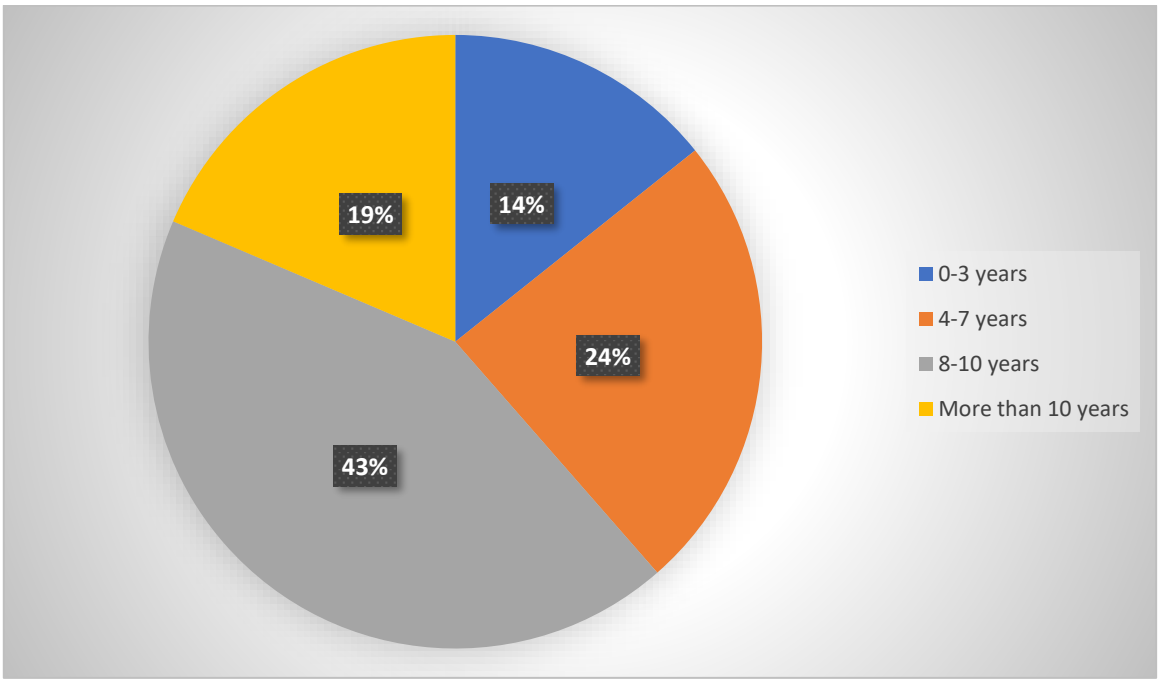

Figure 4.2: Descriptive statistics of respondents based on work Experience

The descriptive statistics of respondents based on experience is given in Table 4.1.that shows the frequency and percentages of work experience.

Table 4.1: Responses based on Work Experience

Experience	Frequency	Percentage
0-3 years	20	14.3%
4-7 years	33 -34	24.3%
8-10 years	60	42.9%
More than 10 years	26	18.6%
Total	**140**	**100%**

4.3.1.2Descriptive Statistics of Respondents Based on Team Size

Figure 4.3: Descriptive statistics of respondents based on organization Size , total 140 respondents participated in the survey. Out of 140 respondents, 37.1% have 35 to 45 team members, 18.6% have 16 to 35 team members and 12.9% have 45 and above team members.

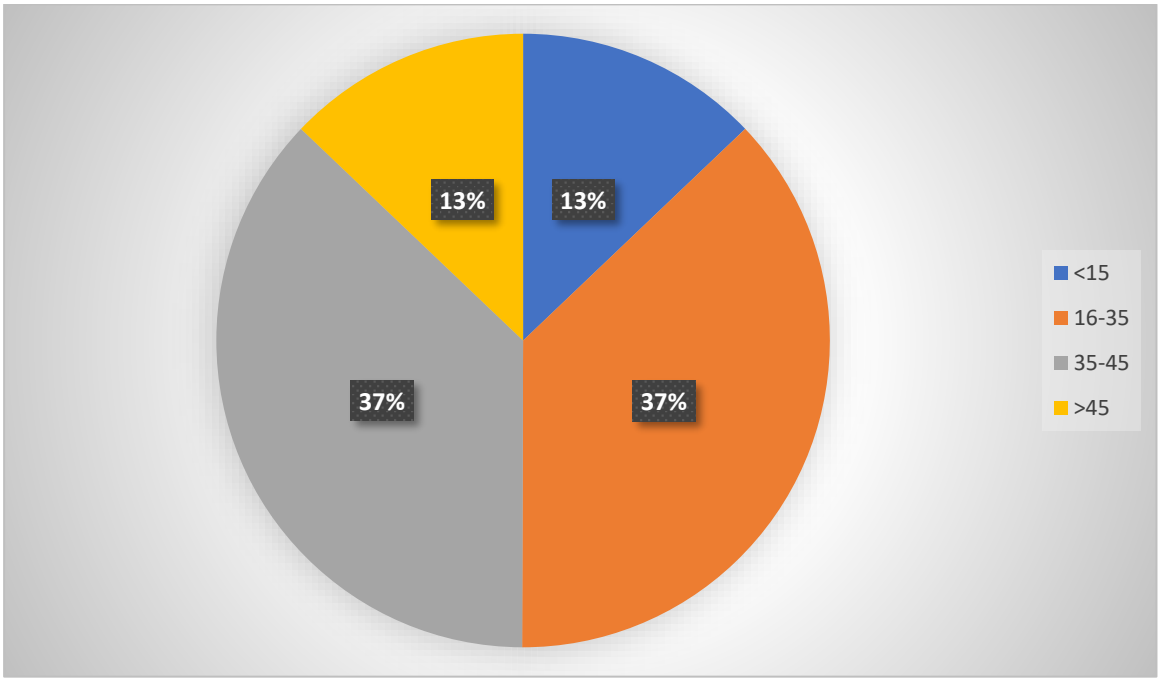

Figure 4.3: Descriptive statistics of respondents based on organization Size

The descriptive statistics of respondents based on team size is given in Table 4.2. that shows the frequency and percentages of team size.

Table 4.2: Responses based on team size

Size of team	Frequency	Percentage
<15	18	12.9%
16-35	52	37.2%
35-45	52	37.1%
>45	18	12.9%
Total	**140**	**100%**

4.3.1.3 Descriptive Statistics of Respondents Based on Age

Figure 4.4: Descriptive statistics of respondents based on age. Total 140 respondents participated in the survey. Out of 140, 18.6% respondents age below 30 years,28.6% respondents age between 30-40, 38.6% age 40-50 age and 14.3% above the 50 ages.

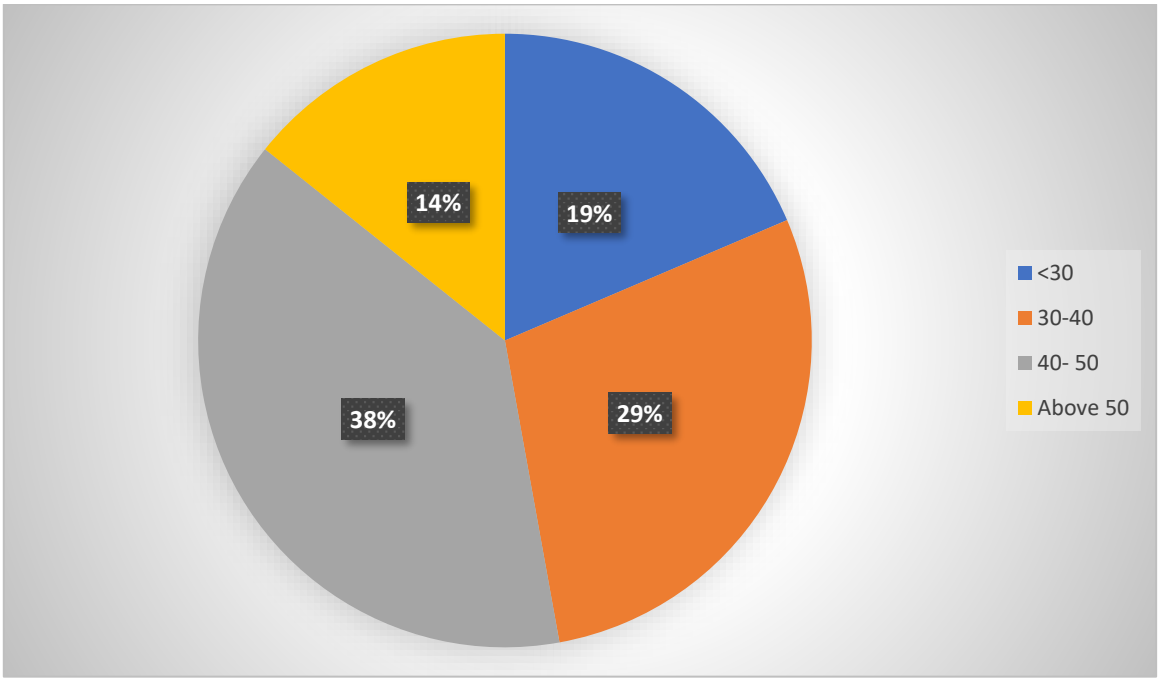

Figure 4.4: Descriptive statistics of respondents based on age

The descriptive statistics of respondents based on respondents age is given in Table 4.3. that shows the frequency and percentages.

Table 4.3: Responses based on age

Age	Frequency	Percentage
<30	26	18.6%
30-40	40	28.6%
40- 50	54	38.6%
Above 50	20	14.3%
Total	**140**	**100%**

4.3.1.4 Descriptive Statistics of Respondents Based on Designation in Organization

Table 4.4 shows the descriptive statistics of respondents based on designation in organization. Software Architect and Senior Manager have higher mean values than the other designation. Other designation includes Sim Officer, School Head, Software architect Network Admin, Scrum Master etc.

Table 4.4: Descriptive statistics of respondents based on designation in organization

Designation	**Frequency**
Consultant	1
Senior Manager	15
Billing Executive	1
Sim Officer	5
School Head	9
Software Architect	20
Network Admin	3
General Manger	3
Finance Manager	2
Scrum Master	3
Network Engineer	5
Tester	7
Devops Engineer	8
Project Manager	10
Video Game Developer	3
IT Assistant	7
Chief Digital Officer	4
Product Owner	3
Software Architect	6
Team Leader	5
Executive Assistants	2
HR Manager	13
Trainer	2
Senior Developer	3
Total	**140**

Figure 4.5 shows the descriptive statistics of respondents based on designation in organization. Software Architect and Senior Manager have higher mean values than the other designation. Other designation includes Sim Officer, School Head, Software architect Network Admin, Scrum Master etc.

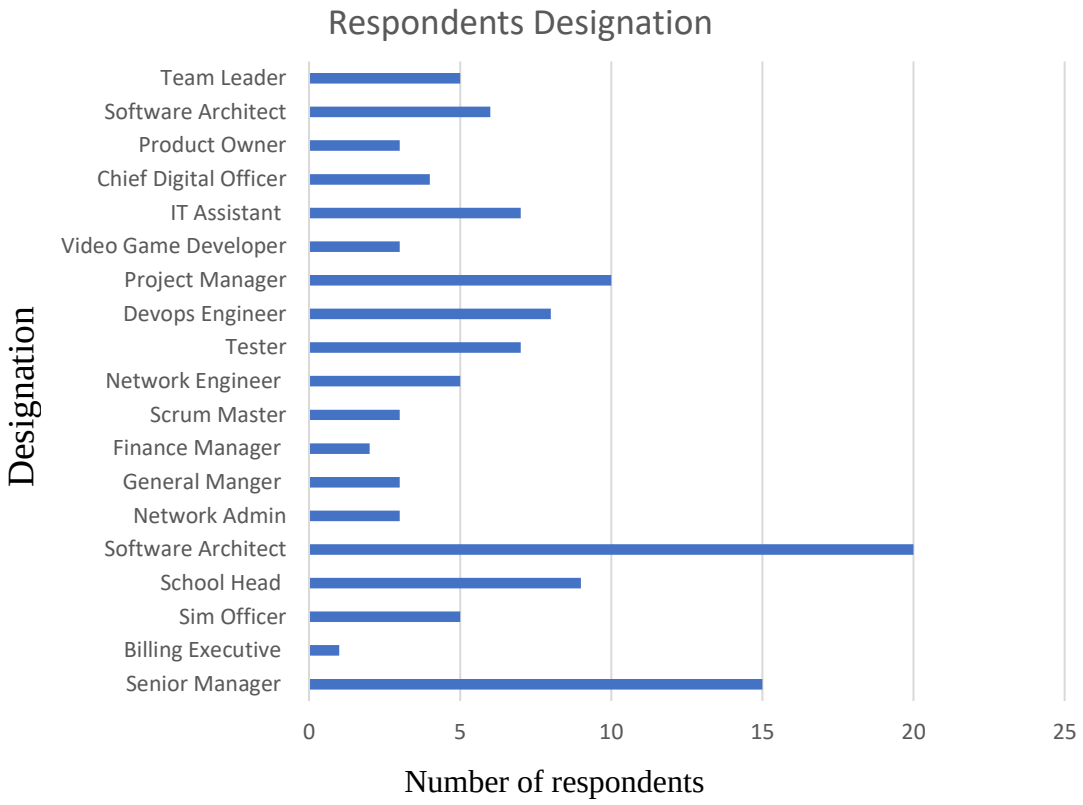

Figure 4.5: Descriptive statistics of respondents based on designation

4.4 Result Analysis Based on Practical Skills

Table 4.5 shows the result analysis based on the student's practical skills. The value of mean, median, standard deviation and variance show that practical skills based on PLOs 1-5 such as Engineering Knowledge, Problem Analysis, Design/Development of Solution, Investigation and Modern Tools Usage.

PLO 1-5 enhance practical skills by equipping them to handle engineering challenges in a productive manner. The threshold value of mean median is 3. If the value of mean and median below the 3 for instance 2.9 that show on average, respondents rate relatively low. The result analysis about practical skills shows that the PLO (1-5) all have mean values greater than 3 i.e. 4.40 to 4.41. Likewise median values between 4.0 to 5.0. The high mean and median score indicate that respondents generally perceive a strongly program learning outcome. The result

analysis regarding standard deviation and variance of all PLO (1-5) was between 0.11 to 0.31 and 0.03 to 0.26 respectively. The low standard deviation and variance indicate that there is a high level of agreement among respondents.

Table 4.5: Result analysis of student's practical skills

PLO	Mean	Median	Standard Deviation	Variance
1.Engineering Knowledge	4.40	5	0.20	0.09
2.Problem Analysis	4.36	5	0.15	0.04
3.Design/Development of Solution	4.34	4.5	0.31	0.26
4.Investigation	4.06	4	0.16	0.10
5. Modern Tools Usage	4.41	5	0.11	0.03

Figure 4.6 shows the result analysis based on the student's practical skills. The value of mean, median, standard deviation and variance show that practical skills based on PLOs 1-5 such as Engineering Knowledge, Problem Analysis, Design/Development of Solution, Investigation and Modern Tools Usage.

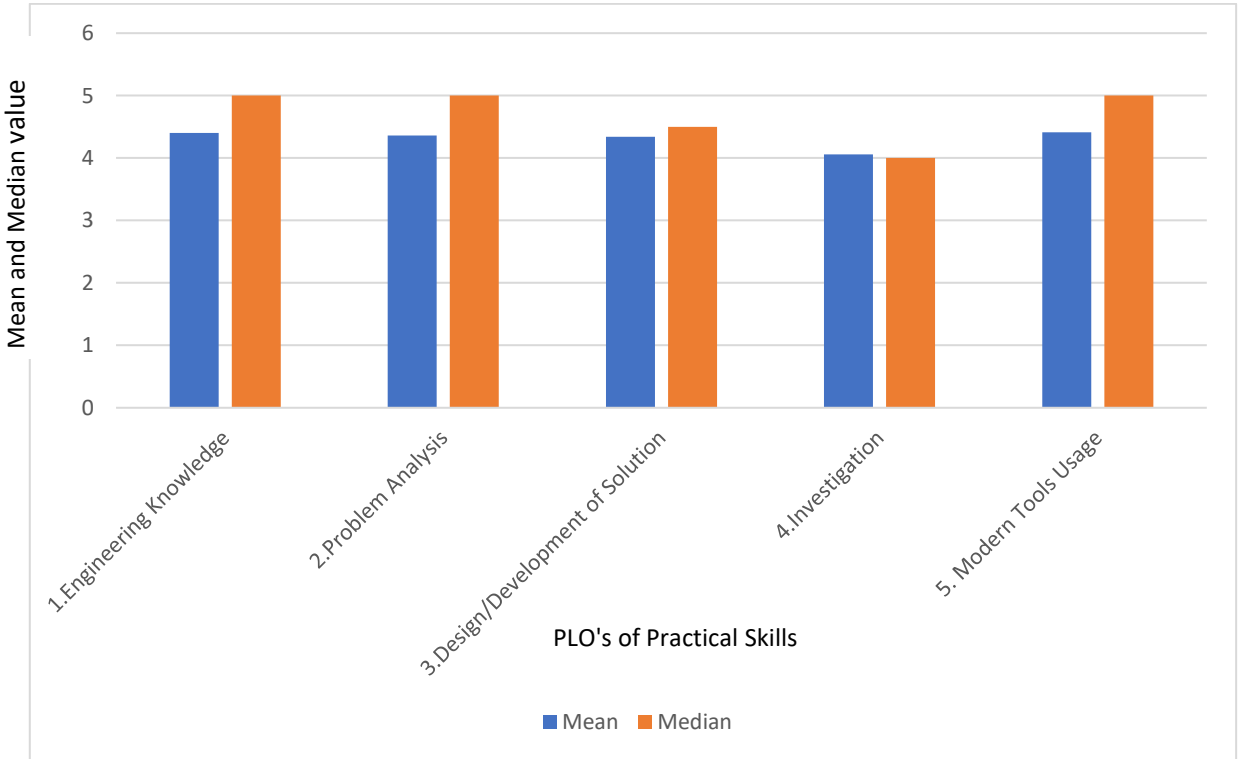

Figure 4.6: Result analysis based on student's practical skills

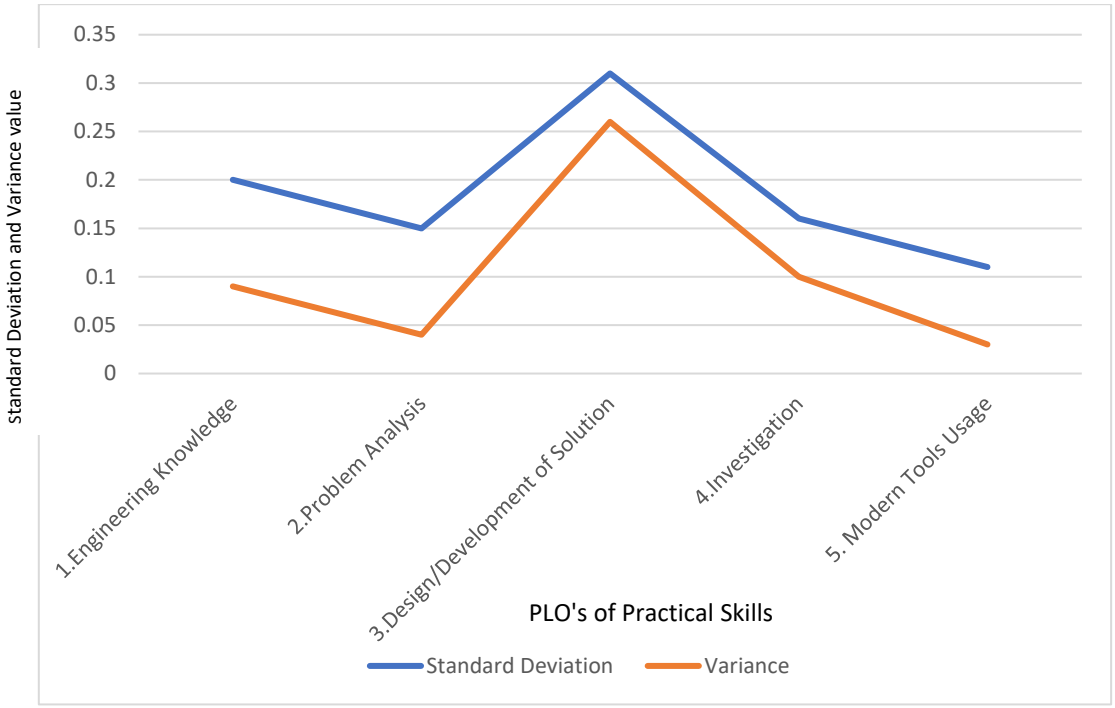

Figure 4.6: Result analysis based on student's practical skills

4.4.1 Result Analysis Based on Engineering Knowledge

The result analysis regarding Engineering Knowledge shows that the mean value is 4.40 and median value is 5 that is above 3, it shows that Engineering Knowledge contributes toward enhancement of practical skills. Similarly standard deviation value is 0.20 and variance value is 0.09 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.7, out of 140 respondents 55.7% participants strongly agree and 35.7% agree that Engineering Knowledge enhances the student's practical skills. Engineering knowledge is the foundation for understanding theories and concepts in different disciplines (e.g., mechanical, civil, electrical engineering). Students applying their theoretical knowledge to real-world situations. Students understand the practical applications through case studies, simulations, and lab experiments.

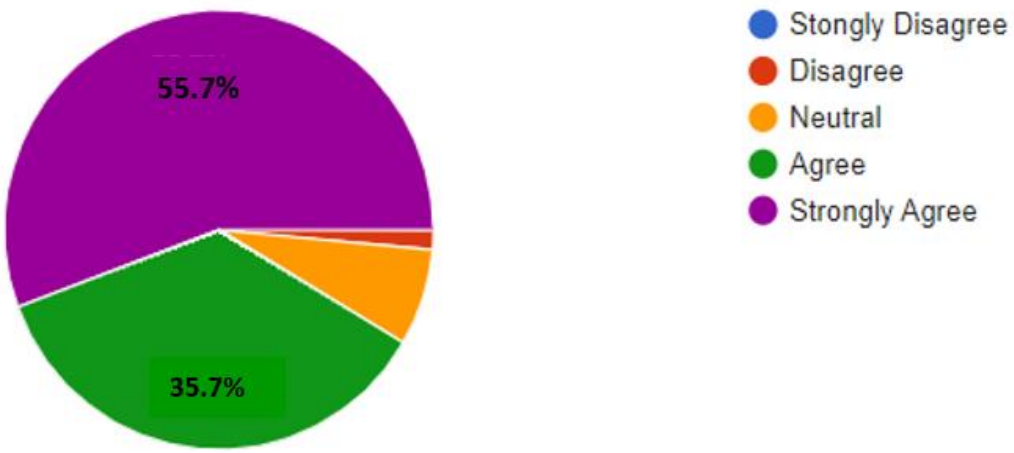

Figure 4.7: Result analysis based on engineering knowledge

4.4.2 Result Analysis Based on Problem Analysis

The result analysis regarding Problem Analysis shows that the mean value is 4.36 and median value is 5 that is above 3, it shows that Problem Analysis contributes toward enhances practical skills. Similarly standard deviation value is 0.15 and variance value is 0.04 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in figure 4.8, out of 140 respondents 52.9% participants strongly agree and 35.1% agree that PLO Problem Analysis effectively evaluates student's practical skills. Students develop the problem analysis skills by solving the complicated task then logically analysing the problem and their limitations. They find the root cause of the problem rather than just addressing the problem. Techniques like fishbone diagrams and root cause analysis diagrams help students for problem-analysis skills.

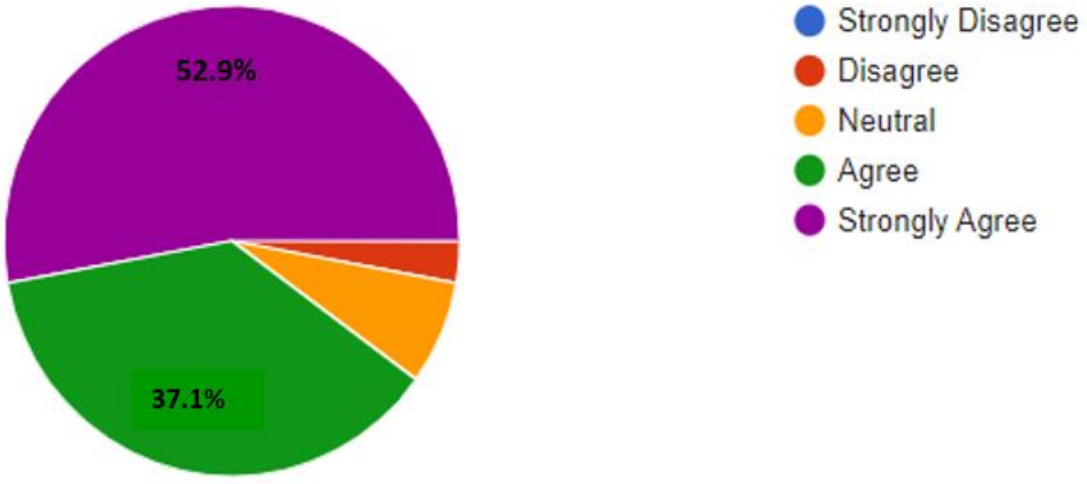

Figure 4.8: Result analysis based on problem analysis

4.4.3 Result Analysis Based on Design/Development of Solution

The result analysis regarding Design/Development of solution shows that the mean value is 4.34 and median value is 4.5 that is above 3, it shows that Design/Development of solution evaluates the student's practical skills. Similarly standard deviation value is 0.31 and variance value is 0.26 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.9, out of 140 respondents 52.9% participants strongly agree, 30% agree and 10% give neutral response. Students have the ability to design system to solve complex engineering problems.

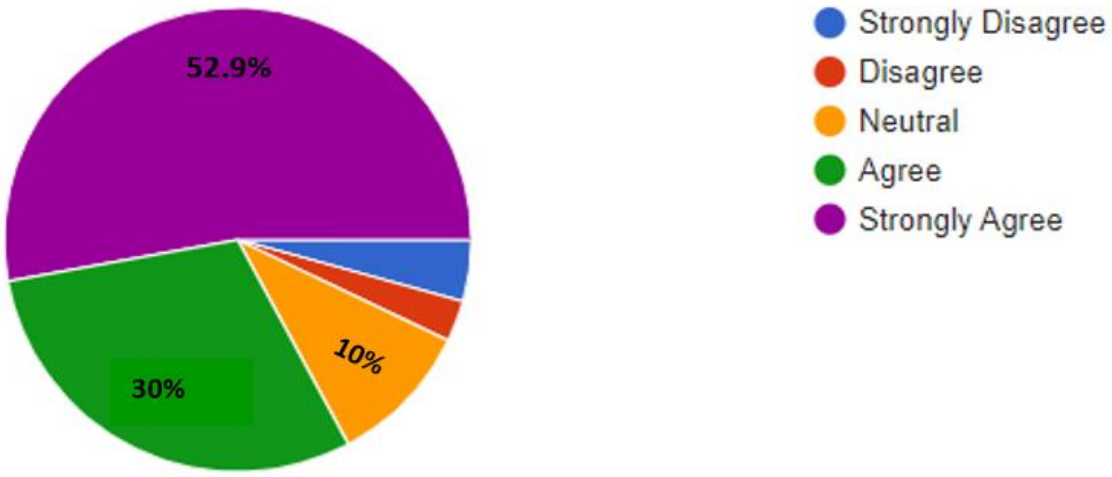

Figure 4.9: Result analysis based on design/development of solution

4.4.4 Result Analysis Based on Investigation

The result analysis regarding Investigation shows that the mean value is 4.06 and median value is 4 that is above 3, it shows that Investigation evaluates the student's practical skills. Similarly standard deviation value is 0.16 and variance value is 0.10 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.10, out of 140 respondents 42.9% participants strongly agree, 45.7% agree, 5% neutral, 1% disagree and 2% strongly disagree that PLO 4 Investigation effectively measure the student's practical skills. Students have the ability to conduct investigations on complex problems using research-based knowledge.

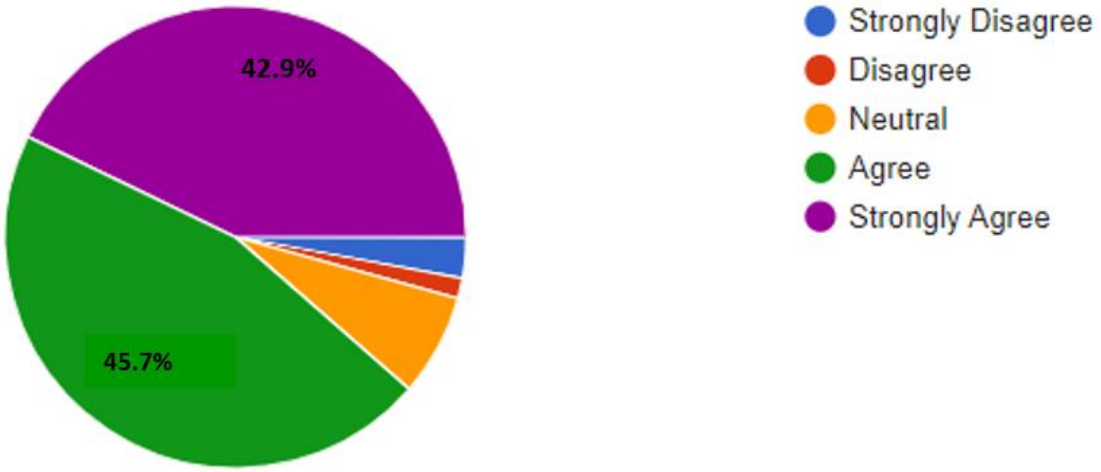

Figure 4.10: Result analysis based on Investigate

4.4.4 Result Analysis Based on Modern Tool Usage

The result analysis regarding Modern tool usage shows that the mean value is 4.41 and median value is 5 that is above 3, it shows that Modern Tool Usage measure the student's practical skills. Similarly standard deviation value is 0.11 and variance value 0.03 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown Figure 4.11, out of 140 respondents 54.3% participants strongly agree, 37.1% agree, 5% neutral and 1% disagree that modern tool usage enhances the student's practical skills. Student's practical skills measure by using modern tools such as computer-aided manufacturing (CAM), computer-aided engineering (CAE), and computer-aided design (CAD). Students have the ability to apply modern techniques and skills in their organization.

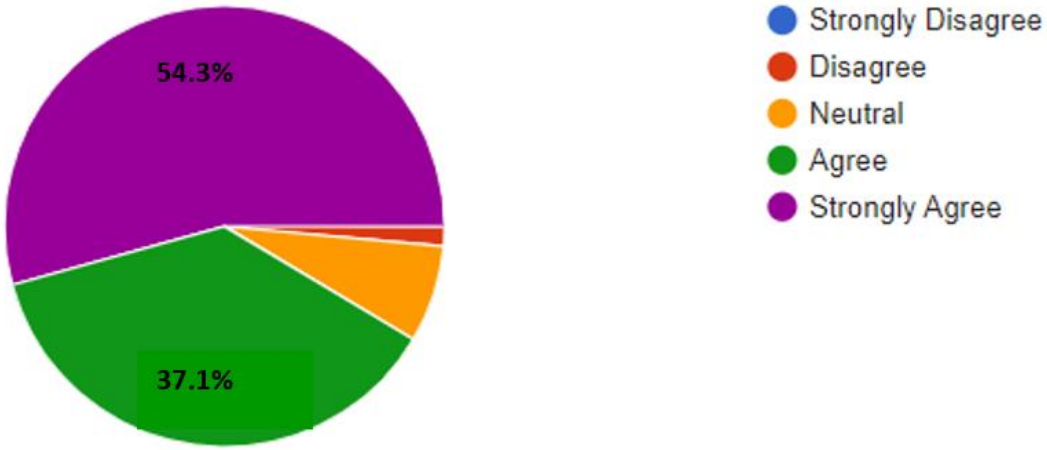

Figure 4.11: Result analysis based on Modern Tool Usage

4.5 Result Analysis Based on Learning Capacity

Table 4.6 show the result analysis of learning capacity. The value of mean, median, standard deviation and variance shows that learning capacity based on PLO (7-12) such as the Engineer and Society, Environment and Sustainability, Ethics, Individual and Teamwork, communication, Project Management and Finance, and Lifelong Learning. The high mean and median score indicate that respondents generally perceive a strongly program learning outcome. The threshold value of mean and median is 3. if the value falls below 3 for instance 2.9 then that shows an average respondent rate relatively low. The result analysis about learning capacity shows that the PLO (7-12) all have mean values greater than 3 i.e. 4.21 to 4.59. Likewise median values between 4.25 to 5.0. The result analysis regarding standard deviation and variance of all PLO (7-12) was between 0.06 to 0.14 and 0.01 to 0.05 respectively. The low standard deviation and variance indicate that there is a high level of agreement among respondents.

Table 4.6: Result analysis based of students learning capacity

PLO	Mean	Median	Standard Deviation	Variance
6.The Engineer and Society	4.51	5	0.11	0.03
7.Environment and Sustainability	4.21	4.25	0.12	0.05
8.Ethics	4.52	5	0.12	0.03
9.Individual and Teamwork	4.39	5	0.06	0.01
10.Communication	4.36	5	0.06	0.01
11.Project Management and Finance	4.23	4.25	0.08	0.03
12.Lifelong learning	4.59	5	0.14	0.03

Figure 4.12 show the result analysis of learning capacity. The value of mean, median, standard deviation and variance shows that learning capacity based on PLO (7-12) such as the Engineer and Society, Environment and Sustainability, Ethics, Individual and Teamwork, communication, Project Management and Finance, and Lifelong Learning.

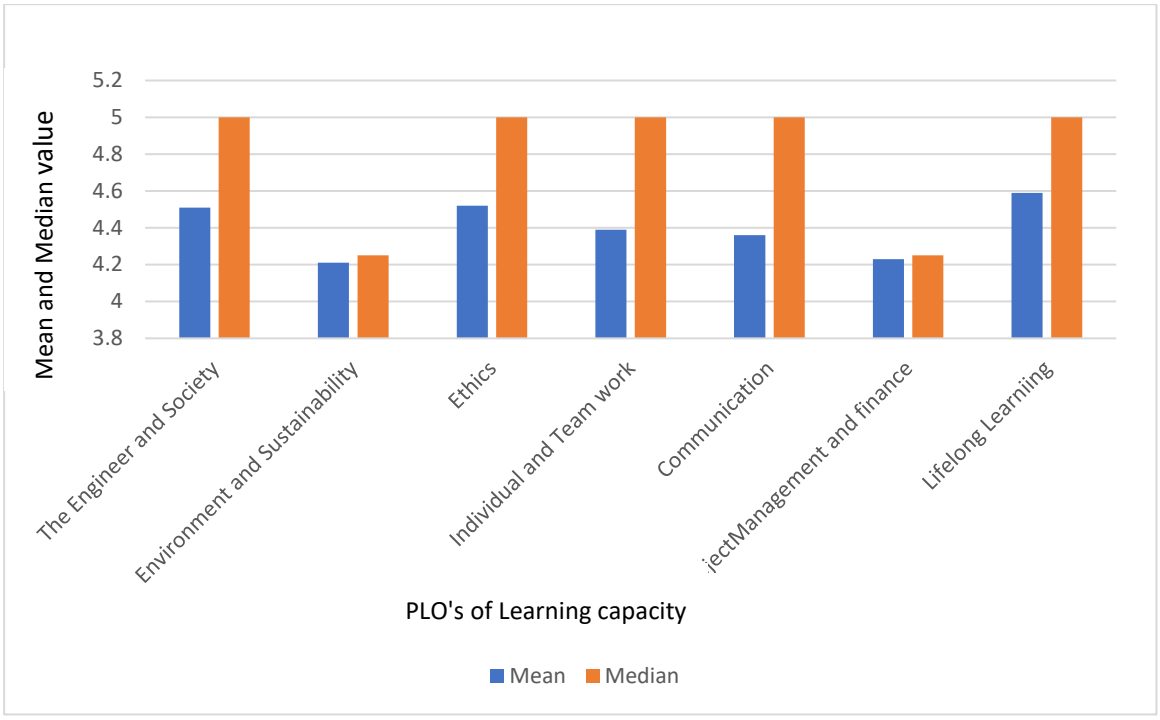

Figure 4.12: Result analysis based on students learning capacity

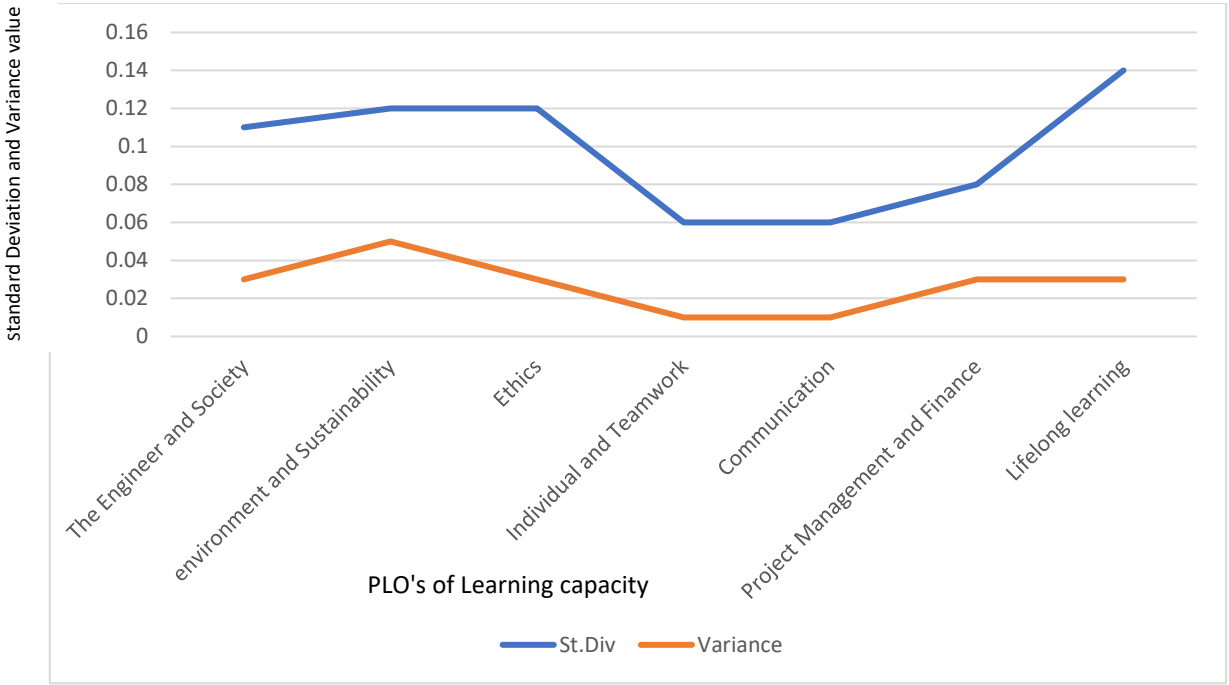

Figure 4.12: Result analysis based on students learning capacity

4.5.1 Result Analysis Based on The Engineer and Society

The result analysis regarding the Engineer and Society shows that the mean value is 4.51 and median value is 5 that is above 3, it shows that the Engineer and Society measure the

learning capacity of students. Similarly standard deviation value is 0.11 and variance value is 0.03 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in figure 4.13, out of 140 respondents 55.7% participants strongly agree, 37.1% agree, 2% neutral and 2% disagree that PLO the engineer and society enhance the student's learning capacity. Students have the ability to understand societal implications of their work and address the global challenges related to health, safety and culture issues.

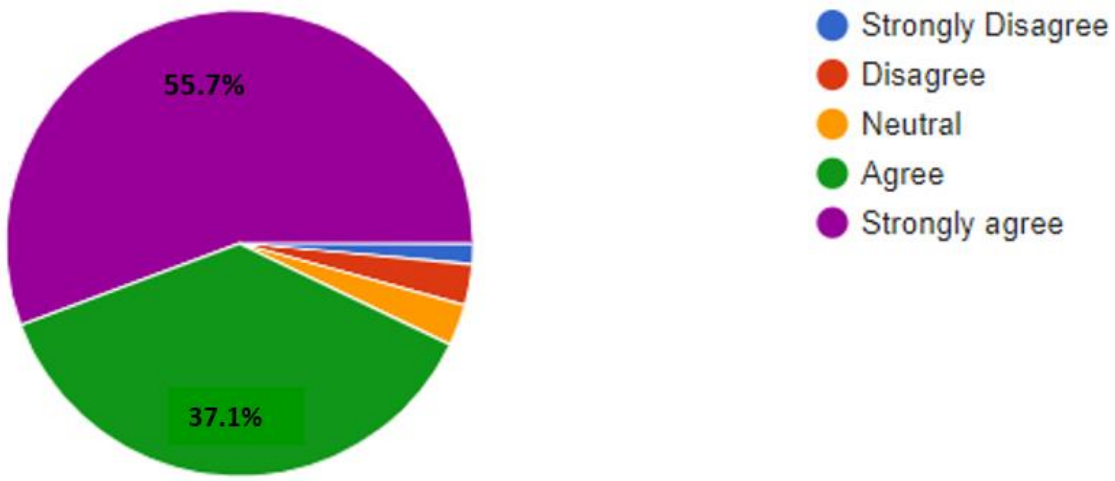

Figure 4.13: Result analysis based on the engineer and society

4.5.2 Result Analysis Based on Environment and Sustainability

The result analysis regarding the Environment and Sustainability shows that the mean value is 4.21 and median value is 4.25 that is above 3, Similarly standard deviation value is 0.12 and variance value is 0.05 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4. 14: Result analysis based on environment and sustainability, out of 140 respondents 48.6% strongly agree, 35.7% agree, 11% neutral and 2% disagree that PLO develops an awareness of how their actions affect international communities and future generations. Students understand the concept of sustainability in engineering context.

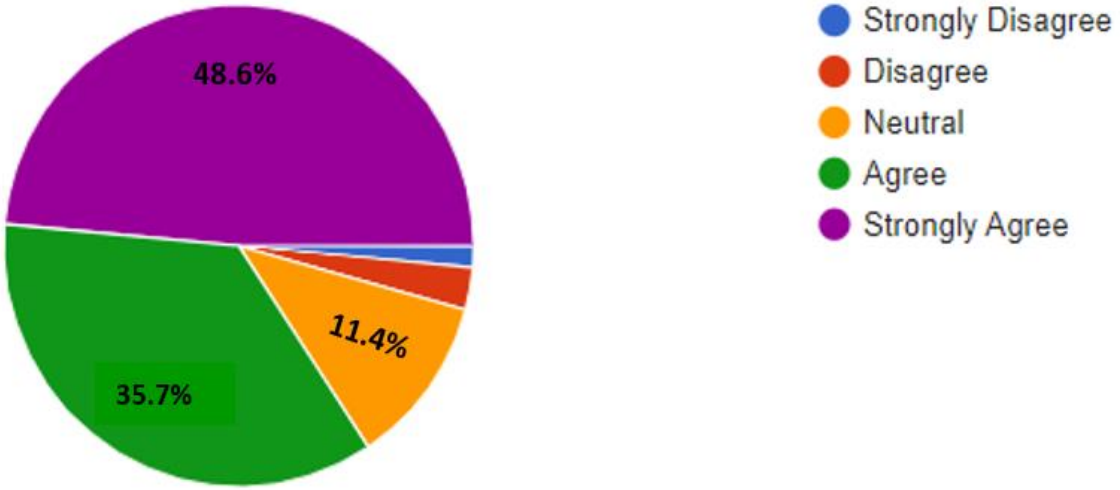

Figure 4. 14: Result analysis based on environment and sustainability

4.5.3 Result Analysis Based on Ethics

The result analysis regarding the Ethics shows that the mean value is 4.52 and median value is 5 that is above 3, Similarly standard deviation value is 0.12 and variance 0.03 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.15: Result analysis based on ethics, out of 140 respondents 50% participants strongly agree, 40% agree, 4% neutral and 2% strongly disagree that PLO ethics enhance the student's learning capacity. With the help of ethical students are prepared to become moral leaders who act morally in difficult situations.

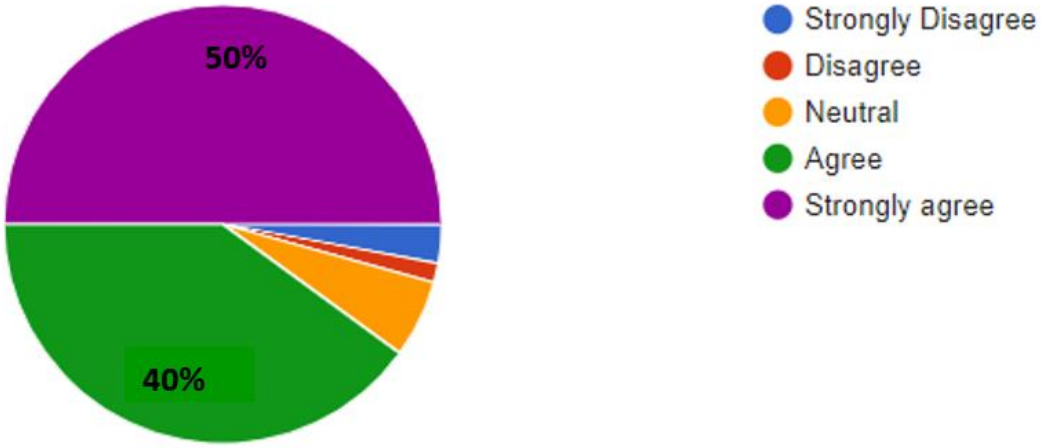

Figure 4.15: Result analysis based on ethics

4.5.4 Result Analysis Based on Individual and Teamwork

The result analysis regarding the Individual and Teamwork shows that the mean value is 4.39 and median values is 5 that is above 3, Similarly standard deviation value is 0.6 and 0.01 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in figure 4.16, out of 140 respondents 60% participants strongly agree, 30% agree, 8.6% neutral and 2% strongly disagree that PLO individuals and teamwork effectively measure the student's learning capacity. Students have the ability to work effectively as individual or member of a working group.

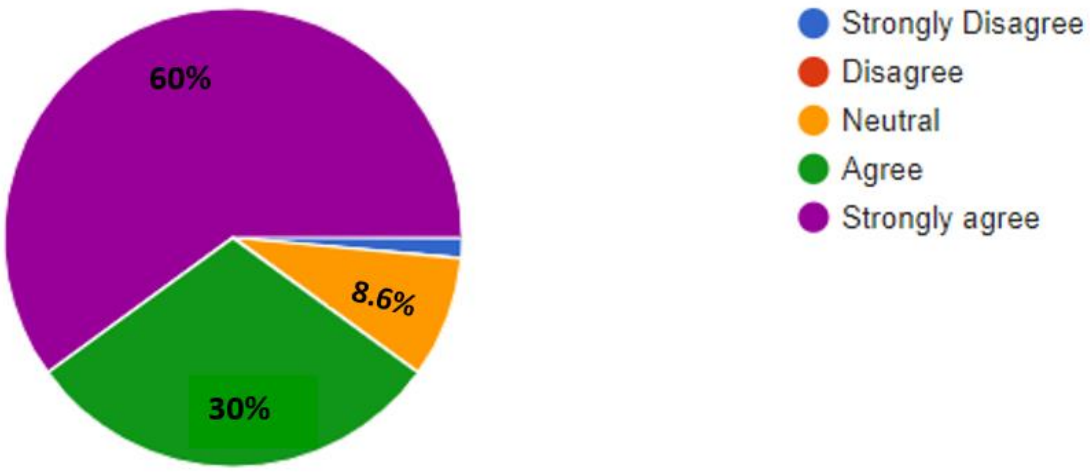

Figure 4. 16: Result analysis based on Individual and Teamwork

4.5.5 Result Analysis Based on Communication

The result analysis regarding the communication shows that the mean value is 4.36 and median value is 5 that is above 3, Similarly standard deviation value is 0.06 and variance value is 0.01 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.17, out of 140 respondents 64.3% participants strongly agree, 27.1% agree, 8.6% neutral response that communication skills evaluate the student's learning capacity. Communication skills are necessary in organization for coordination, idea sharing and conflict resolution. Students get the ability to collaborate well in groups, applying their viewpoints to achieve organization objectives.

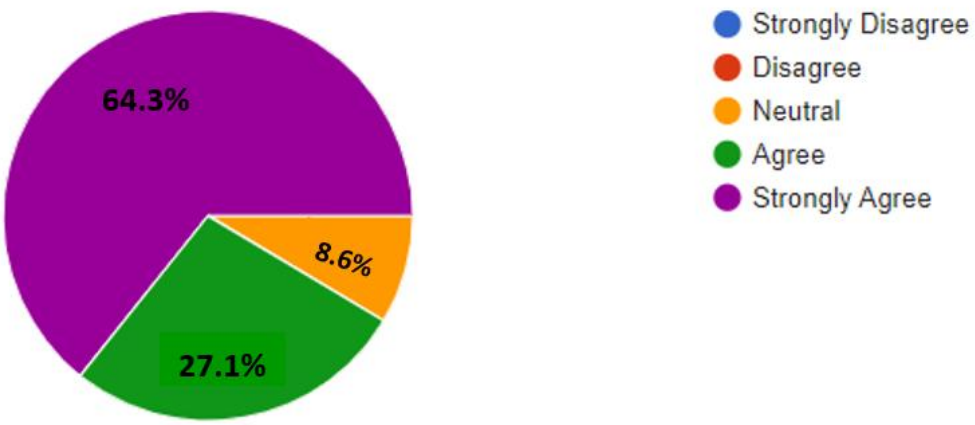

Figure 4. 17: Result Analysis based on Communication

4.5.6 Result Analysis Based Project Management and Finance

The result analysis regarding the Project Management and Finance shows that the mean value is 4.23 and median value is 4.25 that is above 3, Similarly standard deviation value is 0.08 and variance value is 0.03 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.18, out of 140 respondents 52.9% participants strongly agree, 31.4% agree, 10% neutral and 7% disagree that with the help of project management approaches, Students can plan, implement and supervise projects. This technique develops students' organizational skills and their capacity to handle challenging tasks successfully.

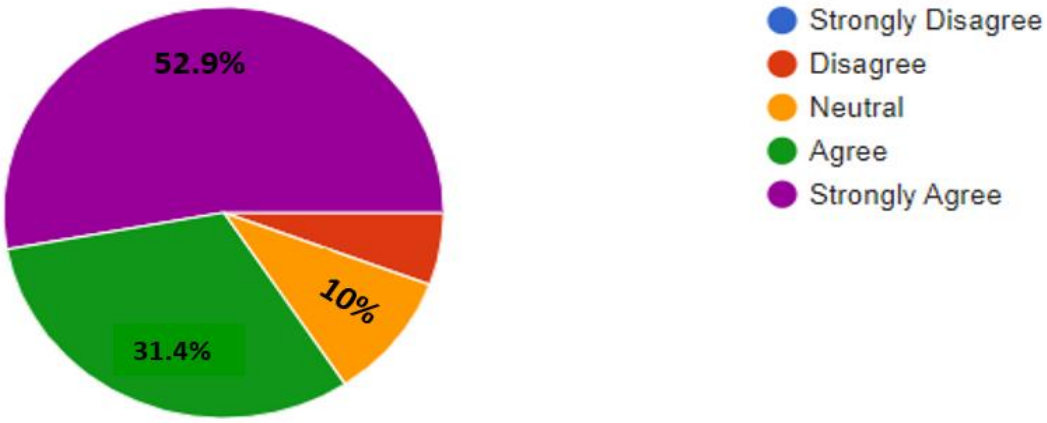

Figure 4.18: Result analysis based on Project Management and Finance

4.5.7 Result Analysis Based on Lifelong Learning

The result analysis regarding the Individual and Lifelong Learning that the mean value is 4.59 and median value is 5 that is above 3, Similarly standard deviation value is 0.14 and variance value is 0.03 that is below the 1. The low standard deviation and variance indicate that there is a high level of agreement among respondents. As shown in Figure 4.19, out of 140 respondents 54.3% participants strongly agree, 31.4% agree, 11% neutral and 2% disagree that PLO lifelong learning enhance the student's learning capacity. Students use lifelong learning for adaptability, to manage hurdles, and use technological advancements. They develop robust solution for challenges and adapt their new learning strategy as necessary. Continuous learning helps to create accurate conclusions.

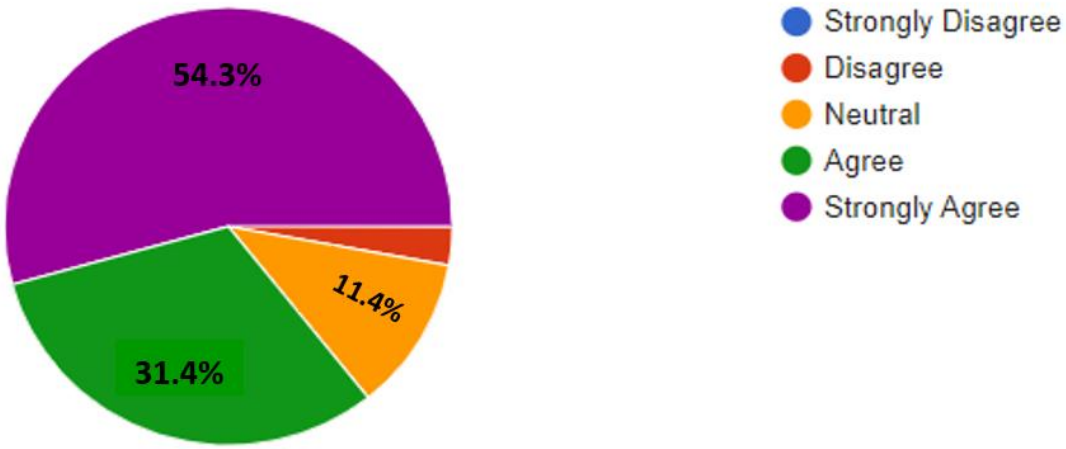

Figure 4.19: Result analysis based on Lifelong Learning

4.6 Construct validity

Construct validity is ensuring that the measurement tools and methods used accurately measure the constructs they are intended to measure. Construct validity is important when research can't be measured or observed directly. There are different types of construct validity. For instance, convergent validity and discriminant validity. Convergent validity refers to the degree to which two measures of the same construct are correlated. It assesses whether different methods or instruments measure the same concept. On the other hand, Discriminant validity refers measure a construct that is distinct from other, unrelated constructs. It measures the construct that is not too closely related to each other [94].

4.7 Cronbach's Alpha Method

Researchers need to evaluate the scale's consistency and reliability. The way the scale is developed and used during data collection also has significant effects on the survey's results [95]. Cronbach's alpha is a statistical measure used to assess the reliability, or internal consistency of survey questionnaire. In survey research, this value helps determine how closely items related the to each other. The validity of the PLO is confirmed in this study by estimating and comparing the values of the Cronbach's alpha. The Cronbach Alpha values of this study is 1.01387164. It shows that values above the 0.7 [96] A high alpha value indicates that the items are consistent in their measurement of that construct. Formula for Cronbach Alpha is given below.

Cronbach's Alpha Method = [(Total questions / Total questions - 1) x (1 - (Sum of the Variance / Total value of Variance))]

No of items	**36**
Sum of variance associated with items	**158.5923395**
Variance associated with the observed total score	**11097**
Cronbach alpha value	**1.01387164**

The Table 4.7 show the result of survey responses based on 5 points Likert scale. For instance, Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. The Table 4.7 show the questions and their values according to SA (2), A (1), N (0), D (-1) and SD (-2). In the column 3, respondents give 70 responses against strongly agree, 60 responses against agree, 10 against neutral, 0 responses against disagree and 0 responses against strongly disagree. The responses multiply with assign value like strongly agree value is 2 and so on. The last column shows the average response against Question 1.

Total responses (Questions 1) = (SA)*2 + (A)*1 + (N)*0 + (D)*(-1) + (SD)*(-2)

Table 4.7: Survey response result

Sr. No	Questions	SA (2)	A (1)	N (0)	D (-1)	SD (-2)	Total responses
1	Does an employee have the ability to apply engineering knowledge to the solution of a complex engineering problem?	70*2=140	60*1=60	10*0=0	0*-1=0	0*(-2) =0	200
2	Does an employee have the ability to relate their professional knowledge to an engineering context?	72*2=144	60*1=60	6*0=0	2*-1=-2	0*(-2) =0	202
3	Does an employee have ability to link theoretical concept to practical ones?	78*2=156	52*1=52	8*0=0	2*-1=-2	0*(-2) =0	206
4	Problem analysis Does an employee have the ability to identify engineering problems?	74*2=148	82*1=82	30*0=0	0*-1=0	0*(-2) =0	230
5	Does an employee have the ability to understand and analyze problems?	74*2=148	56*1=56	10*0=0	4*-1=-4	0*(-2) =0	200
6	Does an employee have the ability to develop analytical skills that help them analyze real world problems?	76*2=152	54*1=54	10*0=0	8*-1=-8	0*(-2) =0	198
7	Design/development of solution Do the employees have the ability to formulate solutions to complex engineering problems?	74*2=148	52*1=52	26*0=0	4*-1=-4	0*(-2) =0	196
8	Does an employee have the ability to design systems that meet specific client requirements?	68*2=136	64*1=64	8*0=0	0*-1=0	0*(-2) =0	200

9	Investigation Does an employee have the ability to conduct investigations into complex problems using research-based knowledge?	70*2=140	70*1=70	10*0=0	0*- 1=0	0*- 2=0	210
10	Does an employee have the ability to use research method, including the design of experiments, analysis to provide a valid conclusion?	74*2=148	50*1=50	36*0=0	0*- 1=0	0*- 2=0	198
11	Modern tools usage Does an employee have the ability to select appropriate resources to solve complex engineering problems?	76*2=152	54*1=54	10*0=0	0*- 1=0	2*- 2=-4	202
12	Does an employee have ability to apply modern engineering and IT tools (like prediction and modelling) while understanding the limitation?	76*2=152	56*1=56	16*0=0	0*- 1=0	0*- 2=0	208
13	Do you agree that employee have the ability to apply modern techniques and skills in their organization?	88*2=176	50*1=50	4*0=0	4*- 1=-4	0*- 2=0	222
14	The engineer and society Does employee have ability to understand societal implication of their work?	78*2=156	58*1=58	4*0=0	4*- 1=-4	2*- 2=-4	206
15	Do employee address the global challenges related to health, safety and culture issues?	92*2=184	42*1=42	6*0=0	2*- 1=-2	0*- 2=0	224
16	Environment and sustainability Does employee have ability to understand the	78*2=156	56*1=56	14*0=0	0*- 1=0	0*- 2=0	212

	concept of sustainability in engineering context?						
17	Does employee understand and evaluates the sustainability and impact of professional engineering work in solving complex problems?	80*2=160	50*1=50	26*0=0	0*-1=0	0*-2=0	210
18	Ethics Do employees have the ability to apply ethical principles in engineering practices?	70*2=140	62*1=62	18*0=0	0*-1=0	0*-2=0	202
19	Does an employee have the ability to avoid conflict of interest? (conflict resolution)	82*2=164	52*1=52	6*0=0	4*-1=-4	0*-2=0	212
20	Does an employee have the ability to understand his/her responsibility to society?	78*2=156	56*1=56	6*0=0	0*-1=0	0*-2=0	212
21	Does an employee practice good ethical behavior?	92*2=184	42*1=42	6*0=0	0*-1=0	0*-2=0	226
22	Is an employee capable of fulfilling client needs?	90*2=180	40*1=40	10*0=0	0*-1=0	0*-2=0	220
23	Does an employee practice safety rules and regulations?	88*2=176	46*1=46	6*0=0	0*-1=0	0*-2=0	222
24	Individual and teamwork Does an employee have the ability to work effectively as an individual?	82*2=168	44*1=44	12*0=0	0*-1=0	2*-2=-4	208
25	Does an employee have the ability to function effectively as a member of a working group?	74*2=148	52*1=52	18*0=0	0*-1=0	0*-2=0	200

26	Does an employee have the ability to function as a leader in a working group?	80*2=160	56*1=56	4*0=0	6*-1=-6	0*-2=0	210
27	Communication Does an employee express verbal and written ideas effectively?	90*2=180	38*1=38	12*0=0	0*-1=0	0*-2=0	218
28	Does an employee have the ability to communicate effectively about complex engineering activities and write reports?	94*2=188	40*1=40	6*0=0	4*-1=-4	2*-2=-4	220
29	Project management and finance Does an employee have the ability to demonstrate knowledge for decision making?	74*2=148	52*1=52	22*0=0	0*-1=0	0*-2=0	200
30	Does an employee have the ability to understand engineering management principles and apply them to their own work?	67*2=134	68*1=68	20*0=0	0*-1=0	0*-2=0	202
31	Lifelong learning Does an employee have the ability to continue learning and professional development within the organization?	76*2=152	48*1=48	16*0=0	4*-1=-4	0*-2=0	196
32	Does an employee understand and recognize the need for self-improvement?	108*2=216	26*1=26	6*0=0	0*-1=0	0*-2=0	242
33	Does an employee have the ability to extract information from various sources?	92*2=184	44*1=44	4*0=0	2*-1=-2	2*-2=-4	222

34	Does an employee possess the capability to undertake self-study?	100*2=200	38*1=38	2*0=0	2*-1=-2	2*-2=-4	232
35	Does an employee have the ability to learn quickly and accept challenges?	94*2=188	46*1=46	0*0=0	0*-1=0	0*-2=0	234
36	Does an employee have the ability to accept constructive ideas and suggestions?	82*2=164	54*1=54	4*0=0	0*-1=0	0*-2=0	218

4.8 Average Weightage Result

In survey, average weightage values refer to the average responses of several survey questions. Averages Weighted provide a more accurate analysis of the overall sentiment or opinion in a survey. Table 4.8 show the result of average weightage response. Following formula is used to obtain Average Weightage values.

Average Weightage Responses = Weightage numbers or values / Total number of responses

All questions are accepted depending on their average weightage scores. The threshold value of Average Weightage is 1.4. As shown in table 4.8 all questions with an average value equal to or greater than 1.4.

Table 4.8: Rejected and Accepted Outcomes

Sr. No	PLO	Questions	Weightage Score/value	Mean weightage value for response	Result
1	**PLO 1** **Engineering** **Knowledge**	Does an employee have the ability to apply engineering knowledge to the solution of a complex engineering problem?	200	200/140=1.42	Accepted
2		Does an employee have	202	202/140=1.44	Accepted

		the ability to relate their professional knowledge to an engineering context?			
3		Does an employee have ability to link theoretical concept to practical ones?	206	206/140=1.47	Accepted
4	**PLO2** **Problem analysis**	Does an employee have the ability to identify engineering problems?	230	230/140=1.64	Accepted
5		Does an employee have the ability to understand and analyze problems?	200	200/140=1.42	Accepted
6		Does an employee have the ability to develop analytical skills that help them analyze real world problems?	198	198/140=1.41	Accepted
7	**PLO3** **Design/development** **of solution**	Do the employees have the ability to formulate solutions to complex engineering problems?	196	196/140=1.4	Accepted
8		Does an employee have the ability to design systems that meet specific client requirements?	200	200/140=1.42	Accepted

9	**PLO4** **Investigation**	Does an employee have the ability to conduct investigations into complex problems using research-based knowledge?	210	210/140=1.5	Accepted
10		Does an employee have the ability to use research method, including the design of experiments, analysis to provide a valid conclusion?	198	198/140=1.41	Accepted
11	**PLO5** **Modern tools usage**	Does an employee have the ability to select appropriate resources to solve complex engineering problems?	202	202/140=1.44	Accepted
12		Does an employee have ability to apply modern engineering and IT tools (like prediction and modelling) while understanding the limitation?	208	208/140=1.48	Accepted
13		Do you agree that employee have the ability to apply modern techniques and skills in their organization?	222	222/140=1.58	Accepted
14	**PLO 6**	Does employee have ability to understand	206	206/140=1.47	Accepted

	The engineer and society	societal implication of their work?			
15		Do employee address the global challenges related to health, safety and culture issues?	224	224/140=1.6	Accepted
16	**PLO 7 Environment and sustainability**	Does employee have ability to understand the concept of sustainability in engineering context?	212	212/140=1.5	Accepted
17		Does employee understand and evaluates the sustainability and impact of professional engineering work in solving complex problems?	210	210/140=1.5	Accepted
18	**PLO 8 Ethics**	Do employees have the ability to apply ethical principles in engineering practices?	202	202/140=1.44	Rejected
19		Does an employee have the ability to avoid conflict of interest? (conflict resolution)	212	212/140=1.51	Accepted
20		Does an employee have the ability to understand his/her responsibility to society?	212	212/140=1.51	Accepted
21		Does an employee practice good	226	226/140=1.61	Accepted

		ethical behavior?			
22		Is an employee capable of fulfilling client needs?	220	220/140=1.57	Accepted
23		Does an employee practice safety rules and regulations?	222	222/140=1.58	Accepted
24	**PLO 9** **Individual and teamwork**	Does an employee have the ability to work effectively as an individual?	208	208/140=1.48	Accepted
25		Does an employee have the ability to function effectively as a member of a working group?	200	200/140=1.42	Accepted
26		Does an employee have the ability to function as a leader in a working group?	210	210/140=1.5	Accepted
27	**PLO 10** **Communication**	Does an employee express verbal and written ideas effectively?	218	218/140=1.55	Accepted
28		Does an employee have the ability to communicate effectively about complex engineering activities and write reports?	220	220/140=1.57	Accepted

29	**PLO 11** **Project** **management and** **finance**	Does an employee have the ability to demonstrate knowledge for decision making?	200	200/140=1.42	Accepted
30		Does an employee have the ability to understand engineering management principles and apply them to their own work?	202	202/140=1.44	Accepted
31	**PLO 12** **Lifelong learning**	Does an employee have the ability to continue learning and professional development within the organization?	196	196/140=1.4	Accepted
32		Does an employee understand and recognize the need for self-improvement?	242	242/140=1.72	Accepted
33		Does an employee have the ability to extract information from various sources?	222	222/140=1.58	Accepted
34		Does an employee possess the capability to undertake self-study?	232	232/140=1.65	Accepted
35		Does an employee have the ability to learn quickly and accept challenges?	234	234/140=1.67	Accepted

36		. Does an employee have the ability to accept constructive ideas and suggestions?	218	218/140=1.55	Accepted

Table 4.9 shows the result analysis of PLO based on aggregate value of mean, median, standard deviation and variance. The aggregate mean value of practical skills is 4.314 and learning capacity value is 4.40. Likewise, the median value of practical skills 4.7 and value of learning capacity 4.78. The aggregate value of mean and median of leaning capacity is more than practical skills. The high mean and median score indicate that respondents generally perceive strongly program learning outcome. Learning capacity scores are more consistent, with most participants scoring higher than the average. The aggregate standard deviation value of practical skills is 0.186 and learning capacity value is 0.098. Likewise, the variance value of practical skills 0.104 and value of learning capacity 0.027. The low standard deviation and variance indicate that there is a high level of agreement among respondents.

Table 4.9: Result analysis of PLOs

	PLOs	Mean	Aggregate Mean PS / LC	Median	Aggregate Median PS /LC	Standard Deviation	Aggregate Standard Deviation PS/LC	Variance	Aggregate Variance PS/LC
Practical Skills (PS)	PLO-1	4.40	4.314	5	4.7	0.20	0.186	0.09	0.104
	PLO-2	4.36		5		0.15		0.04	
	PLO-3	4.34		4.5		0.31		0.26	
	PLO-4	4.06		4		0.16		0.10	
	PLO-5	4.41		5		0.11		0.03	
Learning Capacity (LC)	PLO-6	4.51	4.40	5	4.78	0.11	0.098	0.03	0.027
	PLO-7	4.21		4.25		0.12		0.05	
	PLO-8	4.52		5		0.12		0.03	
	PLO-9	4.39		5		0.06		0.01	
	PLO-10	4.36		5		0.06		0.01	
	PLO-11	4.23		4.25		0.08		0.03	
	PLO-12	4.59		5		0.14		0.03	

4.9 Explanation of Program Learning Outcome

Following is the explanation of Program Learning Outcome (PLO'S).

4.9.1 Engineering Knowledge

Many engineering programs incorporate laboratory work, design projects, and internships that provide hands-on experience to students. These practical activities allow students to apply theoretical knowledge in real-world scenarios, gaining skills using tools, equipment, and technology relevant to their field [97].

Engineering education encourages students to apply critical thinking and innovate new approaches. These skills are important for improving existing technologies and student's practical skills.

4.9.2 Problem Analysis

Students develop the problem analysis skills by solving the complicated task and then logically analysis problem. They find the root cause of problem rather than just addressing the problem. Techniques like fishbone diagrams and root cause analysis diagrams help students for problem-analysis skills [98].

Through problem analysis, students learn to develops hypotheses and then test the hypotheses. This process involves designing experiments, collecting data, and analysing results, which are fundamental to improve practical skills.

4.9.3 Design/Development of Solution

Students design and development project, learn to implement 3D model and apply different tools gives valuable hands-on experience. Students apply theoretical concepts learned in lectures and textbooks and apply in real-world application. This practical application help students to use software and gain practical skills [99].

4.9.4 Investigate

The investigative process encourages students to think creatively and explore innovative solutions to problems. For instance, in research students engage in primary and secondary research, learning how to gather relevant information from various sources. Students design and conduct experiments, developing skills in creating hypotheses, setting up experiments, and controlling variables.

4.9.5 Modern Tools Usage

Student's practical skills measure by using modern tools such as computer-aided manufacturing (CAM), computer-aided engineering (CAE), and computer-aided design (CAD). The use of statistical analysis software help students to generate data-driven decisions and analysing experimental finding. Students learn the collaboration in diverse situations through the use of collaborative platforms [100].

4.9.6 The Engineer and Society

Engineers and society play important roles in enhancing learning capacity. It helps to contribute in educational advancements and resource accessibility in environment. Students apply practical applications by understanding its effect on society. It effectively measures critical thinking and problem-solving skills to address societal concerns [101].

4.9.7 Environment and Sustainability

Integrating Environment and Sustainability into the curriculum can make learning more relevant by connecting students to real-world issues [102]. Different challenges in environment help students to develops environment friendly application. Projects that involve designing eco-friendly solutions encourage higher-order thinking skills, including analysis, synthesis, and evaluation [103].

4.9.8 Ethics

Ethics helps students to make effective decisions. This can lead to better decision-making skills in both academic and professional contexts, fostering responsible and thoughtful leaders. Integrating ethics into learning context help students in professional where ethical behavior is important. Understanding ethical principles helps students develops a strong sense of integrity, which is essential for building trust and credibility in their careers [104].

4.9.9 Individual and Team Work

Individual and teamwork help to measure students learning capacity. Students work effectively as individual and member of working groups helps students to think in new ways which can enhance cognitive flexibility and overall learning. Teamwork fosters interpersonal skills and helps students to navigate social interactions in a professional and effective manner [105].

4.9.10 Communication

In OBE, PLO communication help students to express verbal and written ideas effectively. It enhances learning capacity by communicate effectively about complex engineering activities and write report. This can measure students' ability by express their thoughts clearly both in writing and in oral discussions [106].

4.9.11 Project Management and Finance

Project management teaches students to plan, execute, and monitor projects systematically. This structured approach helps to organize their study tasks, assignments, and projects more effectively. It measures time management skills by manage project deadlines which are important for balancing academic workload and other responsibilities [107].

Understanding financial principles, budgeting, and financial planning enhances students' ability to manage their own finances. It helps students make strong decisions about resource allocation and investment, both in their studies and future professional career. Integrating "Project

Management and Finance" into the curriculum enhances students' learning capacity by developing essential organizational, analytical, and interpersonal skills [108].

4.9.12 Lifelong Learning

In Lifelong learning students see challenges as opportunities for growth. This mindset encourages students to view failures as learning experiences. Students continuously improving their skills and knowledge. This ongoing development helps them stay ahead in their careers and in their study [109].

4.10 Threats to Validity

In research, Threats to validity is important considerations because it effects the accuracy, reliability, and generalizability of the results[110].

4.10.1 Internal Validity

To maintain the internal validity of the research, survey questions are carefully design to ensure that other factors not influence the findings. Data analysis methods carefully chosen to maintain the accuracy and reliability of the findings.

4.10.2 External Validity

For external validity, apply the research's findings to different contexts in order to maintain its external validity. The inclusion of a variety of demographic groups supported the results' generalizability. The research methodology was designed in such way that could help other researchers, which increased the validity and external generalizability of findings.

4.11 Summary

In chapter 4 finding of pilot test and survey result discussed with the help of graph and tables. Different method include mean, median, standard deviation, variance, average weightage response and Cronbach alpha used to analyze the survey results.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Overview

The Chapter 4 was about the finding of survey, result analysis based on practical skills and learning capacity. This chapter summarizes the research's conclusions, contribution, limitation and future work.

5.2 Research Summary

The research is conduct to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and the learning capacity**.** This study is conducted to answer the research question. How effective is Outcome Based Education (OBE) on student's practical skills and the learning capacity?

Survey methodology was used to analyze the effectiveness of Outcome Based Education (OBE) on student's practical skills and the learning capacity**.** Total 140 respondents participate in survey and the target audience of survey was employers of OBE graduates.

The implementing Outcome Based Education (OBE) in educational institutions is effectively evaluates student learning outcomes, such as practical skills and learning capacity. The result analysis of survey shows that the practical skills and learning capacity of students enhance due to the outcome-based education.

5.3 Research Contribution

This study helped to highlight importance of OBE for measures the students learning capacity and practical skills. This study provided significant contribution in the field of Engineering and Computing education by providing the better understanding of OBE.

5.4 Limitations of Research

This study only focuses on the practical skills and learning capacity of students in OBE. The study further enhance by incorporates more responses from employer of OBE graduates This study incorporates the survey methodology to evaluate the learning capacity and practical skills of OBE graduates.

5.5 Future Work

This research measures the practical skills and learning capacity of OBE graduate. The study provides invaluable insight towards the OBE graduates through a survey study in real environment. The conducted research can be further enhanced by performing surveys with added sample size to include more diverse range of industries and geographic region to ensure generalizability of finding from wider aspect. Comaparative studies between OBE and non-OBE graduates can be conducted to get deeper insight into the effectiveness of OBE in enhancing employability skills. Moreover, qualitative studies for instance interview can be performed with employers to get deeper insight. Additionally, the study can be further enhanced by integrating students and faculty perspective along with employer feedback. It may help in more comprehensive evaluation of impact of outcome base education. Furthermore, the study can be performed by focusing other areas like explore deeper integration of OBE with rapidly evolving industry demands, ensuring that educational outcomes reflect emerging technologies like AI, blockchain, data science, and cybersecurity.

5.6 Conclusion

Outcome-based education is modern standard for educational institution. The goal of implementing Outcome Based Education (OBE) in educational institutions all over the world is to evaluates student learning outcomes in innovative way. This study aims to measure attainment of students' students learning capacity and practical skills. The result analysis of survey demonstrate that OBE graduates possess practical skills and learning capacity that enables them to effectively perform in real work environment.

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APPENDICES

APPENDIX A

SURVEY QUESTIONNAIRE

Respected Participant,

I am an MS Software Engineering research student at the National University of Modern Languages. My research topic is **'Evaluating OBE Students' Learning Capacity: Towards a Comprehensive Framework.'** Learning capacity refers to an individual's potential or ability to acquire new skills, and practical skills refer to the ability to perform tasks, solve problems, or accomplish goals effectively in real-world situations through hands-on experience.

The main objective of this survey is to evaluate employees' learning capacities and practical abilities in relation to the Outcome-Based Education (OBE) method. The purpose of the survey is to determine how well outcome-based education evaluates employees' practical skills and learning capacities, and also to assess how well their skill set aligns with company objectives.

All information you provide will remain confidential and will only be used for research purposes.

If you have any questions about the survey, please contact me at the email address aneesanoor555@gmail.com.

Thank you for taking the time to complete this questionnaire.

Demographic Question		
1. Your Age 1. < 30 2. 30-40 3. 40-50 4. Above 50	**2.Gender** 1. Male 2. Female	**3.Size of your team** 1. <15 2. 16-25 3. 25-35 4. 35-45 5. >45
4.Experience 1. 0-3 Years 2. 4-7 Years 3. 8-10 Years 4. More than 10 Years	**5.Your role/designation in the organization?** _____	

Core Questions						
Sir No.	**Item**	**Scale**				
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

1	**Practical skills** Engineering Knowledge Does an employee have the ability to apply engineering knowledge to the solution of a complex engineering problem?	1	2	3	4	5
2	Does an employee have the ability to relate their professional knowledge to an engineering context?	1	2	3	4	5
3	Does an employee have ability to link theoretical concept to practical ones?	1	2	3	4	5
4	Problem analysis Does an employee have the ability to identify engineering problems?	1	2	3	4	5
5	Does an employee have the ability to understand and analyze problems?	1	2	3	4	5
6	Does an employee have the ability to develop analytical skills that help them analyze real world problems?	1	2	3	4	5
7	Design/development of solution Do the employees have the ability to formulate solutions to complex engineering problems?	1	2	3	4	5
8	Does an employee have the ability to design systems that meet specific client requirements?	1	2	3	4	5
9	Investigation Does an employee have the ability to conduct investigations into complex problems using research-based knowledge?	1	2	3	4	5
10	Does an employee have the ability to use research method, including the design of experiments, analysis to provide a valid conclusion?	1	2	3	4	5
11	Modern tools usage Does an employee have the ability to select appropriate resources to solve complex engineering problems?	1	2	3	4	5
12	Does an employee have ability to apply modern engineering and IT tools (like prediction and modelling) while understanding the limitation?	1	2	3	4	5
13	Do you agree that employee have the ability to apply modern techniques and skills in their organization?	1	2	3	4	5
14	**Learning capacity**	1	2	3	4	5

	The engineer and society Does employee have ability to understand societal implication of their work?					
15	Do employee address the global challenges related to health, safety and culture issues?	1	2	3	4	5
16	Environment and sustainability Does employee have ability to understand the concept of sustainability in engineering context?	1	2	3	4	5
17	Does employee understand and evaluates the sustainability and impact of professional engineering work in solving complex problems?	1	2	3	4	5
18	Ethics Do employees have the ability to apply ethical principles in engineering practices?	1	2	3	4	5
19	Does an employee have the ability to avoid conflict of interest? (conflict resolution)	1	2	3	4	5
20	Does an employee have the ability to understand his/her responsibility to society?	1	2	3	4	5
21	Does an employee practice good ethical behavior?	1	2	3	4	5
22	Is an employee capable of fulfilling client needs?	1	2	3	4	5
23	Does an employee practice safety rules and regulations?	1	2	3	4	5
24	Individual and teamwork Does an employee have the ability to work effectively as an individual?	1	2	3	4	5
25	Does an employee have the ability to function effectively as a member of a working group?	1	2	3	4	5
26	Does an employee have the ability to function as a leader in a working group?	1	2	3	4	5
27	Communication Does an employee express verbal and written ideas effectively?	1	2	3	4	5
28	Does an employee have the ability to communicate effectively about complex engineering activities and write reports?	1	2	3	4	5

29	Project management and finance Does an employee have the ability to demonstrate knowledge for decision making?	1	2	3	4	5
30	Does an employee have the ability to understand engineering management principles and apply them to their own work?	1	2	3	4	5
31	Lifelong learning Does an employee have the ability to continue learning and professional development within the organization?	1	2	3	4	5
32	Does an employee understand and recognize the need for self-improvement?	1	2	3	4	5
33	Does an employee have the ability to extract information from various sources?	1	2	3	4	5
34	Does an employee possess the capability to undertake self-study?	1	2	3	4	5
35	Does an employee have the ability to learn quickly and accept challenges?	1	2	3	4	5
36	Does an employee have the ability to accept constructive ideas and suggestions?	1	2	3	4	5

APPENDIX B

PROFILE OF SURVEY RESPONDENTS

Designation	Frequency
Consultant	1
Senior Manager	15
Billing Executive	1
Sim Officer	5
School Head	9
Software Architect	20
Network Admin	3
General Manger	3
Finance Manager	2
Scrum Master	3
Network Engineer	5
Tester	7
Devops Engineer	8
Project Manager	10
Video Game Developer	3
IT Assistant	7
Chief Digital Officer	4

Product Owner	3
Software Architect	6
Team Leader	5
Executive Assistants	2
HR Manager	13
Trainer	2
Senior Developer	3
Total	140

APPENDIX C

KEYWORDS/CONSTRUCTS THAT ARE USED IN QUESTIONNAIRE

Keywords/constructs	Description
Engineering knowledge	Apply the knowledge of mathematic, natural science, engineering fundamental and engineering specialization for solution of complex engineering problem.
Problem analysis	Identify, formulate, research literature and solve complex engineering problem.
Design/ development of solutions	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health, and safety, cultural, societal and environmental considerations
Investigation	Conduct investigations of complex problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions
Modern tool usage	Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering problems, with an understanding of the limitations
The engineer and society	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems
Environment and sustainability	Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts
Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice
Individual and teamwork	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
Communication	Communicate effectively on complex engineering activities with the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
Project management and finance	Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work as a member and leader in a team, to manage projects and in multi-disciplinary environments
Lifelong learning	Recognize the need for, and have the preparation and ability to engage in, independent and life-long learning in the broadest context of technological change

APPENDIX D

RESPONDENTS RESPONSES

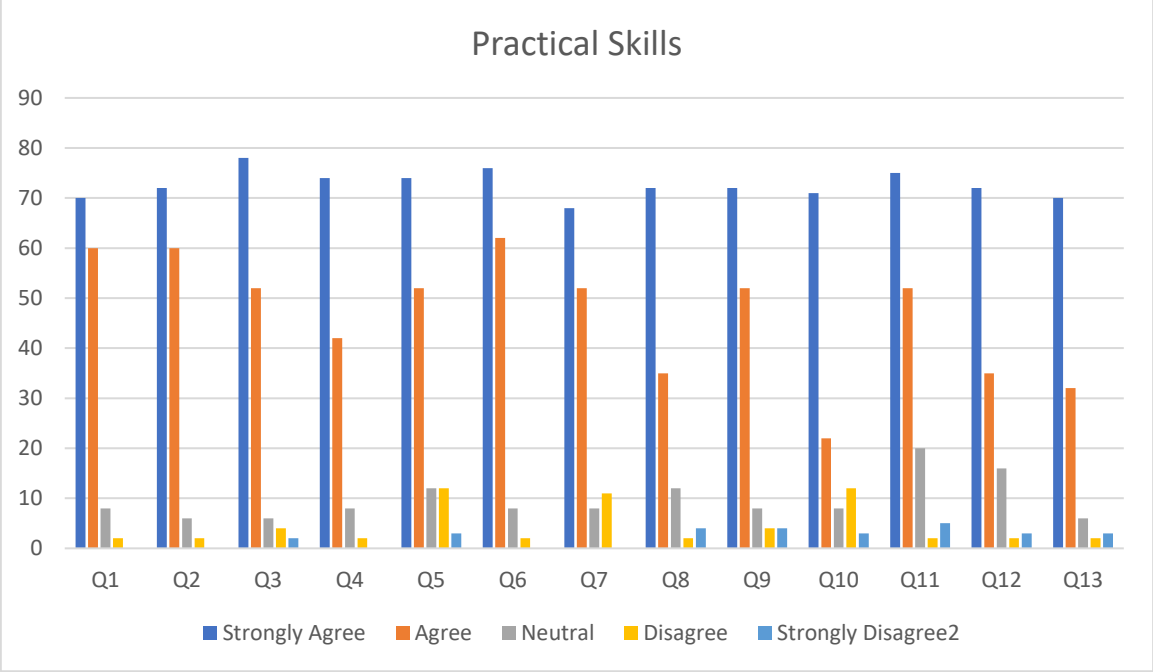

Figure 1 survey responses based on practical skills

The Figure 1 presents survey responses across 13 questions (Q1 to Q13), showing the distribution of five response categories: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The Strongly Agree category, represented by blue bars, consistently has the highest values across all questions, indicating that most respondents strongly supported that OBE measure the attainment of graduates. The Agree category, shown in orange, follows as the second most common response, supporting the overall positive sentiment.

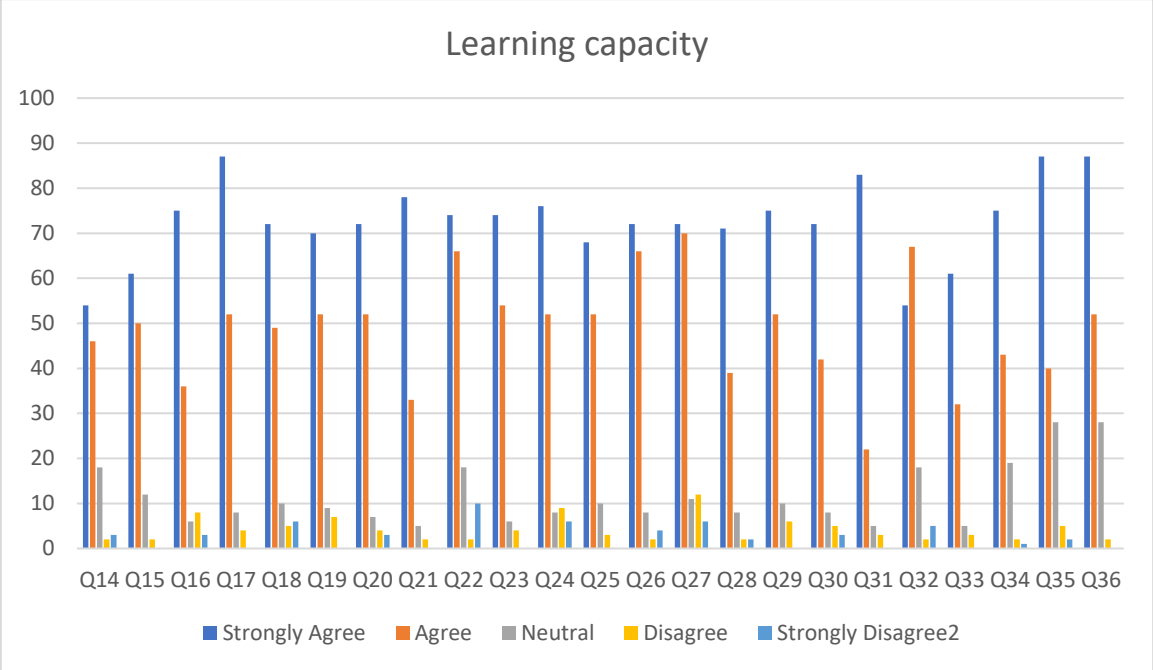

Figure 2 survey responses based on learning capacity

The Figure 2 represents survey responses related to "Learning Capacity" across multiple questions (Q14 to Q36). The responses are categorized into five groups: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. The Strongly Agree category, represented by blue bars, indicating that a majority of respondents strongly support the statements related to learning capacity. The Agree category, shown in orange, follows as the second most common response, supporting the positive perception among the participants. The Disagree and Strongly Disagree categories, shown in yellow and light blue, appear in minimal proportions, indicating that very few respondents expressed disagreement with the statements.

APPENDIX E

RESULT ANALYSIS OF PLO'S

	PLOs	Mean	Aggregate Mean PS / LC	Median	Aggregate Median PS /LC	Standard Deviation	Aggregate Standard Deviation PS/LC	Variance	Aggregate Variance PS/LC
Practical Skills (PS)	PLO-1	4.40	4.314	5	4.7	0.20	0.186	0.09	0.104
	PLO-2	4.36		5		0.15		0.04	
	PLO-3	4.34		4.5		0.31		0.26	
	PLO-4	4.06		4		0.16		0.10	
	PLO-5	4.41		5		0.11		0.03	
Learning Capacity (LC)	PLO-6	4.51	4.40	5	4.78	0.11	0.098	0.03	0.027
	PLO-7	4.21		4.25		0.12		0.05	
	PLO-8	4.52		5		0.12		0.03	
	PLO-9	4.39		5		0.06		0.01	
	PLO-10	4.36		5		0.06		0.01	
	PLO-11	4.23		4.25		0.08		0.03	
	PLO-12	4.59		5		0.14		0.03	

APPENDIX F

FORMULAS OF MEAN MEDIAN VARIANCE AND STANDARD DEVIATION

- **Mean**

$$\text{Mean} = \frac{\text{Sum of all numbers}}{\text{Total numbers}}$$

$$\text{Mean} = \frac{4.40+4.36+4.34+4.06+4.41}{5}$$

$$\text{Mean} = 4.314$$

- **Median (Middle Value)**

- If odd count, the middle value is the median.

  Example: 4.40, 4.36,4.34,4.06,4.41

  - Numbers: 4.34→ Median (middle value).

- **Variance (Spread of Data)**

$$\text{Variance} = \frac{\sum(\text{Each value} - \text{Mean})^2}{Total\ value}$$

$$\text{Variance} = \frac{\sum(4.40-4.314)^2(4.36-4.314)^2(4.34-4.314)^2(4.06-4.314)^2(4.41-4.314)^2}{5}$$

Variance = 0.186

- **Standard Deviation (How much data varies from the mean)**

$$Standard\ Deviation = \sqrt{Variance}$$

$$Standard\ Deviation = \sqrt{0.186}$$

Standard Deviation = 0.104