DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

Evaluating the Level of Satisfaction in Higher Education Students with Technical Support Services Provided Using FUZZY TOPSIS Decision Method

by

Geeta Pursan

19652470

Submitted in Fulfilment of the Requirements for the Degree of

Master in Information and Communications Technology

In the Faculty of Accounting and Informatics

At the Durban University of Technology

Supervisor: Dr Timothy T. Adeliyi

Co-Supervisor: Dr Seena Joseph

Submitted: December 2023

DECLARATION

I, *Geeta Pursan*, declare that:

(i) The research included in this dissertation is all original work by me, unless otherwise noted.

(ii) This dissertation hasn't been submitted to any other university for a degree or test.

(iii) Unless clearly identified as being sourced from other people, this dissertation does not contain any data, photos, graphs, or other information that belongs to another person.

(iv) Unless clearly noted as being a source from other scholars, this dissertation does not contain any writing from other people. In cases when quotations from other written sources have been made:

• Although their words have been changed, the general knowledge that they are credited with has been cited.

• Their writing has been cited and put in quote marks where their exact words have been utilized.

(v) This dissertation does not use text, pictures, or tables that have been copied and pasted from the Internet unless the source has been acknowledged and is listed in the dissertation in the Reference Section.



Student: Geeta Pursan **Supervisor** **Co-Supervisor**

Student Number: 19652470

3 May 2024

Date

ACKNOWLEDGEMENTS

I'm very grateful to God, the Almighty.

I would like to thank Dr Timothy Adeliyi, my supervisor, and Dr Seena Joseph, my co-supervisor. I appreciate your mentoring, advice, counselling, encouragement and most importantly, you overseeing my work.

We are grateful for the help and direction provided by Drs Alveen Singh and Jeanette Wing.

For letting the students take part in my research investigations, I am grateful to the Durban University of Technology (DUT).

My grateful family: Nischal, I want to thank you for your patience and support throughout my research studies. I appreciate your unwavering support. I'm really grateful to you. Radhika and Yashvir my lovely children, I appreciate you giving up your time, and doing everything I should have done but didn't because of my education. You kids are wonderful.

Many thanks to Dr Julius Aroba for the technical advice and assistance.

Many thanks to everyone who, whether deliberately or unknowingly, assisted me. Even while I may not be able to name every one of you or even recall how you helped me; I am aware that my success is a result of your support and participation.

Godspeed to everyone.

TABLE OF CONTENTS

DECLARATION ii
ACKNOWLEDGEMENTS iii
TABLE OF CONTENTS iv
LIST OF FIGURES vii
LIST OF TABLES viii
ABBREVIATIONS x
ABSTRACT xii
CHAPTER ONE: INTRODUCTION 1
1.1 Background 1
1.2 Problem Statement 2
1.3 Research Aim 3
1.3.1 Research Objectives and Research Questions 3
1.4 Research Significance 3
1.5 Research Output 4
1.6 Structure of Dissertation 4
CHAPTER TWO: LITERATURE REVIEW 6
2.1 Higher Education Institutions (HEIs) 6
2.2 Information Technology Technical Support Services 7
2.3 Service Quality 7
2.4 Service Quality Measurements 8
2.5 Service Quality Models 9
2.5.1 Haywood-Farmer's Model 9
2.5.2 Importance – Performance Analysis Model 10
2.5.3 SERVQUAL Model 10
2.5.4 Lehtinen and Lehtinen Model and Grönroos Model 12
2.5.5 SERVPERF Model 13
2.5.6 HEdPERF Model 13
2.5.7 Other Service Quality Models Developed 13
2.6 Service Quality Evaluation Models for HEI 15
2.7 Service Quality of Technical Support in Higher Education 19
2.8 The Need for Information Technology Support Services 20
2.9 Student Satisfaction in Higher Education 20
2.10 Student Satisfaction with Technical Support Service in Higher Education 21
2.11 Technique for Order Preference by Similarity to Ideal Solution 22
2.12 Empirical Studies on Service Quality in Higher Education 22
2.13 Empirical Studies on IT Technical Support Services 23

2.14 Empirical Studies on Fuzzy TOPSIS Method 24
2.15 Systematic Literature Review 25
2.15.1 *Identification:* 26
2.15.2 *Screening:* 26
2.15.3 *Eligibility*: 26
2.15.4 *Included*: 27
2.16 Summary 28
CHAPTER THREE: RESEARCH METHODOLOGY 29
3.1 Principal Component Analysis 30
3.2 SERVQUAL 36
3.2.1 SERVQUAL Model for Questionnaire 37
3.2.2 Student Satisfaction 37
3.2.3 Demographic Factors 38
3.2.4 SERVQUAL Dimensions 38
3.2.5 Research Paradigm 39
3.2.6 Research Methodology 39
3.2.7 Research Design 39
3.2.8 Research Setting and Target Population 40
3.2.9 Sampling Strategy 40
3.2.10 Sample Size 40
3.2.11 Reliability 40
3.2.12 Validity 41
3.2.13 Ethical Considerations 41
3.2.14 Recruitment of Participants 41
3.2.15 Pilot Study 41
3.2.16 Data Collection 42
3.3 Fuzzy TOPSIS 45
3.3.1 Biographical Analysis 45
3.3.2 Inferential Analysis 45
3.3.3 Decision Theory 45
3.3.4 Fuzzy TOPSIS Model 47
3.4 Summary 52
CHAPTER FOUR: PRESENTATION OF RESULTS AND DISCUSSION 53
4.1 Survey Statistical Analysis 53
4.1.1 Sample 53
4.1.2 Research Instrument 53
4.1.3 Reliability and Validity Statistics 54
4.1.4 Biographical Data Analysis 54
4.1.5 Survey Results Overview 59

4.1.6 Cross Tabulations 74
4.1.7 Chi-square Tests by Pearson 79
4.2 Fuzzy TOPSIS Results 80
4.3 Discussion of Results 88
4.4 Summary 90
CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS 91
5.1 Study Summary 91
5.2 Study Conclusions 92
5.3 Contributions and Implications of Study 93
5.4 Limitations of Study 94
5.5 Future Research 94
REFERENCES 95
ANNEXURE A: An Example Using FUZZY TOPSIS 117
ANNEXURE B: Ethics Clearance to Conduct the Study 124
ANNEXURE C: Permission to Conduct Study at DUT 125
ANNEXURE D: Survey Questionnaire Sent to all Students that had Contacted the WhatsApp Technical Support Team 127
ANNEXURE E: Study Originality Report 135

LIST OF FIGURES

Figure 2.1. Haywood-Farmer's Model 9
Figure 2.2. IPA Model 10
Figure 2.3. SERVQUAL Model 11
Figure 2.4. Grönroos Model 12
Figure 2.5. Conceptual Model 16
Figure 2.6. SERVQUAL Model 17
Figure 2.7. Conceptual Model 18
Figure 2.8. Flow Diagram of Database Search using PRISMA 28
Figure 3.1. The Research Framework 29
Figure 3.2. Framework with 11 Main Aspects of Student IT Technical Support Service Evaluation 37
Figure 3.3. Membership Function F(x) of a Triangular Fuzzy number Ã. 48
Figure 4.1. Responses Received by Age 57
Figure 4.2. Respondents by Gender 57
Figure 4.3. Respondents by Study Type 58
Figure 4.4. Respondents by Study Level 58
Figure 4.5. Respondents by Department 59
Figure 4.6. SERVQUAL Index per Dimension 64
Figure 4.7. Responses on Service Response 66
Figure 4.8. Responses on Service Assurance 67
Figure 4.9. Responses on Trustworthiness and Loyalty 68
Figure 4.10. Responses on Service Commitment 69
Figure 4.11. Responses on Staff Competence 69
Figure 4.12. Responses on Reputation 70
Figure 4.13. Responses on Technical Support Staff 71
Figure 4.14. Responses on Communication Material Provided 71
Figure 4.15. Responses on Method of Communication 72
Figure 4.16. Responses on Location Convenience 73
Figure 4.17. Responses on Satisfaction Level 74

LIST OF TABLES

Table 2.1 Inclusion and Exclusion Criteria 27
Table 3.1 Qualitative and Quantitative IT Technical Support Services (ITSS) Factors for PCA 30
Table 3.2 Rank Attributes with 5-Factor Loadings 36
Table 3.3 IT Technical Support Service Factors for the Questionnaire 43
Table 3.4 Linguistic Terms for Sub-Criteria Ratings 49
Table 3.5 Linguistic Terms for Criteria Ratings 49
Table 4.1 SERVQUAL Dimensions by Questionnaire Items 53
Table 4.2 Cronbach's Alpha Score for Questionnaire Items 54
Table 4.3 Demographic Profiles of Respondents 55
Table 4.4 Responses on students' perception of IT technical support services provided 60
Table 4.5 Overall SERVQUAL Index 64
Table 4.6 Satisfaction Level vs. Age 76
Table 4.7 Satisfaction Level vs. Study Level 78
Table 4.8 Satisfaction Level vs. Gender 79
Table 4.9 Chi-square Tests by Pearson 80
Table 4.10 Linguistic and Fuzzy Triple for Rating Criteria 80
Table 4.11 Measures for Criteria 81
Table 4.12 Linguistic and Fuzzy Triple for Criteria 81
Table 4.13 Aggregated Scores and BNP values for Criteria 81
Table 4.14 Ranked Criteria based on BNP values 82
Table 4.15 Linguistic and Fuzzy Triple for Sub-Criteria 82
Table 4.16 Numeric Labels for the Sub-Criteria 83
Table 4.17 Assigned Rating by Decision-Makers 83
Table 4.18 Normalized Fuzzy Decision Matrix 83
Table 4.19 FNIS and FPIS 85
Table 4.20 Closeness Coefficient of Each Sub-Criteria 87
Table 5.1 Alignment of the Research 92
Table 3.6 Linguistic Terms for Sub-Criteria Ratings 117
Table 3.7 Linguistic Terms for Criteria Ratings 118
Table 3.8 Linguistic Language Rankings for Sub-Criteria 118
Table 3.9 Linguistic Language Technical Support Expert Weightings of Criteria 119
Table 3.10 Fuzzy Triple Representations for Sub-Criteria Rankings Matrix 119
Table 3.11 Fuzzy Triple Representations for Expert Weightings Matrix 119
Table 3.12 Aggregated Sub-Criteria Rankings Matrix 120
Table 3.13 Aggregated Criteria Weightings Matrix 120
Table 3.14 Normalized Sub-Criteria Rankings Fuzzy Matrix 120
Table 3.15 Weighted Normalized Sub-Criteria Rankings Fuzzy Matrix 121

Table 3.16 Fuzzy FNIS and FPIS values 121
Table 3.17 Distance of Each Weighted Sub-Criteria from the FNIS and FPIS Values 122
Table 3.18 Closeness Coefficient of Each Sub-Criteria 122
Table 3.19 Ranking of Sub-Criteria 122

ABBREVIATIONS

AVE	: Average Variation Extracted
AWS	: Amazon Web Services
CFA	: Confirmatory Factor Analysis
EFA	: Exploratory Factor Analysis
EP	: Evaluated Performance
FNIS	: Fuzzy Negative Ideal Solution
FPIS	: Fuzzy Positive Ideal Solution
F-TOPSIS	: Fuzzy Technique for Order Preference by Similarity to Ideal Solution
HEdPERF	: Higher Education Performance
HEIs	: Higher Education Institutions
IPA	: Importance-Performance Analysis model
IT	: Information Technology
ITIL	: Information Technology Infrastructure Library
LMS	: Learning Management Systems
MCDM	: Multiple-Criteria Decision-Making
NFI	: Normalized Fit Index
NSE	: National Student Enquiry
OUNL	: Open Universiteit in the Netherlands
PCA	: Principal Component Analysis
RO	: Research Objectives
RQ	: Research Questions
SD	: Standard Deviation
SEM	: Structural Equation Modelling Technique
SERVQUAL	: Service Quality
SERVPERF	: Service Performance Model
SPSS	: Statistical Package for Social Science
SQM-HEI	: Service Quality Measurement in Higher Education in India

SRMR : Standardized Root Mean Square Residual

TEVT : Technical Education Vocational Training Institutes

TOPSIS : Technique for Order of Preference by Similarity to Ideal Solution

TSSQ : Technical Support Service Quality instrument

URL : Uniform Resource Locator

VIF : Variance Inflation Factor

ABSTRACT

The use of information and communication technologies at higher education institutions is no longer an option, but rather a need. Information Technology support is an essential factor that entails giving end users assistance with hardware and software components. Technical support for information technology has been recognized as a crucial element linked to student satisfaction because it helps students understand, access, and use technology efficiently. IT technical support services are essential for higher education students to succeed in their studies. However, the quality of IT technical support services can vary widely from institution to institution. Student satisfaction with IT technical support services is an important measure of the quality of education that students receive. Conversely, evaluating student satisfaction is a complex task, as it involves subjective assessments of service quality.

This dissertation used a framework that combines three approaches: Principal Component Analysis (PCA), Service Quality (SERVQUAL), and Fuzzy TOPSIS. The successful implementation of IT technical support is aided by identifying the essential success criteria that enable efficient and effective support for students and instructors. Hence the main aim of this study is to identify and rank the key success factors for the successful implementation of IT technical support at higher education institutes. 81 key success factors identified from 100 research papers were analyzed using principal component analysis. The findings led to the identification and ranking of 25 PCs. From these findings, the SERVQUAL dimensions that featured at the top-most rankings were selected, and that being: tangibility, reliability, assurance, empathy, and responsiveness. These factors were used in the development of the questionnaire that was sent to students which measured student perceptions of the five dimensions of service quality. The proposed approach is implemented in a higher education institution in South Africa. The questionnaires were administered to a specific target of students, only those student participants' who had contacted the IT technical team for IT technical support via the WhatsApp service communication method formed part of the study. Once data was collected, SERVQUAL which is a well-established scale for measuring service quality was used to calculate the average score for each dimension of service quality. The dimensions of service quality where students were most and least satisfied were identified. Finally, Fuzzy TOPSIS, which is a multi-criteria decision-making (MCDM) method that handles uncertainty and vagueness in data was used to rank the IT technical support services based on student satisfaction.

The SERVQUAL results showed that the overall satisfaction level of students with IT technical support services led to a final score of 60 percent, meaning that the support services rendered were acceptable to students. The Fuzzy TOPSIS rankings identified the sub-criteria, overall being satisfied with the support services rendered as rank number one. As can be deduced that since both the SERVQUAL and Fuzzy TOPSIS methods have nominated satisfaction level as the common factor,

this research indicates that the IT technical support services rendered by the IT technical support team are adequately sufficient and that the needs of the students are met and that the services rendered are highly appreciated by the students at the Durban University of Technology. This research proves that the IT support team is compliant with the quality of IT technical support services rendered to students at the Durban University of Technology however, the IT support service can be improved by the proactiveness of the technical team. This research contributes by providing useful information highlighting factors that can be used to examine areas in educational institutions that need to receive continuous and special care to generate high student satisfaction; ensure future success and gain a competitive advantage. These factors can assist the management of HEI in determining the success or failure of an institution in terms of the technical support provided to students and student satisfaction. The results of this evaluation can be used by other HEIs to improve the quality of IT technical support services and to ensure that they are meeting the needs of students.

CHAPTER ONE: INTRODUCTION

1.1 Background

Information technology technical support includes installation of hardware and software, user manuals drawn up, maintenance of network structure and updating of software, and making sure that network security is always at its optimal to prevent any breaches, provides help desk support to students' by assisting with Wi-Fi connectivity, email boxes inaccessible, email password not working and assist with other technical queries (Stewart *et al.* 2013).Technical support is one of the critical aspects that encourage users to accept technology (Sánchez, Hueros and Ordaz 2013).Technical support is crucial for both academics and students. Academics need technical support to ensure that they have access to necessary resources and have been trained with the skills needed to integrate the use of technology in classes. Students need technical support to assist them to acquire knowledge and skills that will enable them to complete courses.

Kumtepe *et al.* (2018) defines support services as a whole set of services that are provided to students, academics, administrative, and technical staff to use the institutions' resources effectively to create quality learning. Support services are the additional help that students receive that include but are not limited to help desk services, academic advising, library services, financial aid services, and technical support services. It is the key element in enhancing students' learning experiences (Lee *et al.* 2011).

Simmons (2013) states that support is needed to help students meet their learning outcomes, to help them cope with the demands of student academic life, and to complete their studies. Rovai and Downey (2010) and Rotar (2022) emphasize that student support promotes student satisfaction. Floyd and Casey-Powell (2004) and Smith (2007) complement that due to the increase in student enrolment at higher education institutions, there is a growing demand for student support services. Hall (2010) states student support services are needed to provide assistance and reassurance to academically disadvantaged students to make a smooth changeover into higher education life. Shikulo and Lekhetho (2020) states that student support services are critical at higher educational institutions, in the ever-transforming distance education. In March 2020 when the world suddenly awoke to the COVID-19 pandemic, the need for support services at higher education institutions rapidly increased to reduce the problems experienced by the sudden shift from traditional to remote learning (Hossain *et al.* 2020). The pandemic further aggravated the issue of access to student support services at all higher education institutions (Mayisela, Govender and Hodgkinson-William 2022).

Higher education institutions (HEIs) play a major role in the development of socio-economic science and technology. Among the several stakeholders in higher education, students are the main

customers of universities (Raaper 2019). However, students are the primary receivers of services provided at HEIs (Abdullah 2006b; Annamdevula and Bellamkonda 2016). Service quality at higher education institutions is constantly being evaluated by students so they can select the university they would like to attend (Shahijan, Rezaei and Guptan 2018). Union (2017) states that HEIs focus should be to improve students' skills, focus on social dimensions, encourage innovation, and review performance management systems to reward good practices. Students have been found to leave educational institutions because of poor skill sets and capabilities (H.B.R. 2019). Higher education institutions are expected to provide quality education and services to the most vulnerable (Union 2017). Constant engagement between other universities should take place so that challenges relating to innovation can be overcome together. Students are provided with opportunities to improve their academic careers with lifelong learning, which allows students to improve their knowledge and skills as per community needs and develop goals (Bank 2010). For HEIs to gain a competitive advantage, they need to find effective and creative ways to attract, retain and build strong bonds with students (Ilias *et al.* 2008). Evaluating student satisfaction provides university administrators with a clear picture of students' expectations, needs, and feelings during service delivery (Xue, Zhao and Guo 2008). With these criteria identified, university administrations can improve the quality of services provided to students.

Hence, it is significant to evaluate students level of satisfaction with information technology technical support services in higher education institutes.

1.2 Problem Statement

Information Technology (IT) technical support services are essential for higher education students to succeed in their studies (Yousapronpaiboon 2014; Amoozegar *et al.* 2017; Alshammari 2020; Alduraywish, Patsavellas and Salonitis 2021; Puriwat and Tripopsakul 2021; Pursan, Adeliyi and Joseph 2023). Student satisfaction with IT technical support services is an important measure of the quality of education that students receive (Teeroovengadum, Kamalanabhan and Seebaluck 2016; Nguyen *et al.* 2020; Dinh *et al.* 2021). However, the quality of IT technical support services can vary widely from institution to institution (Ramphal and Nicolaides 2014; Firdous and Farooqi 2019). Bucarey *et al.* (2021) attempted to assess learners' satisfaction in remote teaching and learning. Technological quality, teacher quality, and service quality were the variables used to quantify student satisfaction. Blau, Snell and Goldberg (2021) compared students satisfaction levels in terms of support students received pre-pandemic to initial phases of the pandemic. It was noted that the support students received remained unchanged regardless of the COVID-19 pandemic. Evaluating student satisfaction can provide university administrators a clear picture of students' expectations, needs, and feelings during service delivery (Xue, Zhao and Guo 2008). Identifying these criteria can help improve the quality of services provided to students. However, no adequate research has been

found that focuses specifically on evaluating information technology support services and students level of service satisfaction in higher education institutions therefore this research will fill the gap.

1.3 Research Aim

This study aims to evaluate students' level of satisfaction with information technology technical support services in higher education institutes.

1.3.1 Research Objectives and Research Questions

The aim of this study is achieved with the following research objectives and the related questions on how to implement these objectives:

RO1: To identify suitable factors associated with information technology technical support services for higher education students by conducting a systematic literature review.
RQ1: What are the key factors associated with information technology technical support services for higher education students, as identified in existing literature?

RO2: To develop a questionnaire to measure student satisfaction level with information technology technical support services.
RQ2: What are the key factors influencing student satisfaction with information technology technical support services, and how can these factors be ranked and used to develop a valid questionnaire for measuring student satisfaction in the context of higher education institutions?

RO3: To evaluate student information technology technical support services at higher education institutions.
RQ3: How can the Fuzzy TOPSIS decision-making method be effectively applied to evaluate the quality of information technology technical support services for students in higher education institutions?

1.4 Research Significance

The significance of this research is rooted in the growing importance of digital technologies in higher education institutions, and the role of IT technical support services in enhancing the learning experience of students. Within this context, the research aims to evaluate the satisfaction level of higher education students with IT technical support services by using the Service Quality method and Fuzzy Technique for Order Preference by Similarity to Ideal Solution method to provide a more comprehensive and accurate evaluation of student satisfaction. This research also has practical implications for higher education institutions by highlighting the importance of IT technical support

services in enhancing student satisfaction levels, and providing insights into areas that need improvement.

The unique contribution of this study is to evaluate the student IT technical support service competence – this research will highlight the areas that need to be improved in terms of technical support services provided to students at Durban University of Technology. The proper implementation of this study will attract more students at higher education institutions. Students will be motivated to study at Durban University of Technology knowing that “top-level” technical support services are being offered to them. After all, universities should aim to be “Student-Centeredness”.

1.5 Research Output

This study has contributed towards a research publication in the Volume 14 Issue 6 June 2023 issue of the International Journal of Advanced Computer Science and Applications (IJACSA). The article is available at the given URL https://dx.doi.org/10.14569/IJACSA.2023.0140630.

1.6 Structure of Dissertation

Chapter 1: Introduction

This chapter covers the background of the study, research problem statement, research aim and objectives, research questions and the significance of research.

Chapter 2: Literature Review

This chapter reviews the body of research on the degree to which higher education institutions' services are appreciated by their students. In this chapter the research gap is found that no prior research study has concentrated solely on the satisfaction level of students at higher educational institutions in terms of the satisfaction levels of students in higher education institutions in terms of the information technology technical support services that are provided.

Chapter 3: Research Methodology

The research approach employed in this study is presented in this chapter. It covers principal component analysis to identify and rank the important success indicators for information technology technical support services in higher education institutions, SERVQUAL, data collection, target population and sample procedure, instrument size and validity, method of analysis, and methods for reliability and validity, decision theory and Fuzzy TOPSIS method.

Chapter 4: Presentation of Results and Discussion

The descriptive and comprehensive inferential statistical findings of this investigation are presented and discussed in this chapter. These results demonstrate how, or to what extent, the study's research questions were addressed, as well as how well its goals were achieved.

Chapter 5: Summary, Conclusion and Recommendations

The complete study is summarized in this chapter. It comprises of the framework that was employed, the data analysis findings, and the study's addition to the body of knowledge in both research and practice. The chapter also identifies some of the study's shortcomings and makes some suggestions for potential directions for future research.

CHAPTER TWO: LITERATURE REVIEW

This chapter presents extant literature on information technology (IT) technology support services in higher education institutions. The chapter addresses the following key topics: higher education institutions; technical support services; service quality; service quality measurements, service quality models; other service quality models developed; service quality evaluation models for HEI; service quality of technical support in higher education; the need for information technology support services; student satisfaction in higher education; student satisfaction with technical support service in higher education; SERVQUAL framework; Technique for Order Preference by Similarity to Ideal Solution and SERVQUAL and Fuzzy TOPSIS. Further, empirical studies on service quality in higher education, IT technical support services, Fuzzy TOPSIS method, and a systematic literature review are covered in this chapter.

IT technical support services play a critical role in ensuring the smooth functioning of IT infrastructure, resolving technical issues, and providing IT training and resources to users. The satisfaction of higher education students with computer administrative services is a vital factor in determining the effectiveness of these services. In this chapter the research gap is found that no prior research study has concentrated solely on the satisfaction level of students at higher educational institutions in terms of the satisfaction levels of students in higher education institutions in terms of the information technology technical support services that are provided.

2.1 Higher Education Institutions (HEIs)

Higher education institutions (HEIs) have a significant impact on the advancement of socioeconomic science and technology. Students, employers, and the government are all stakeholders in higher education. These stakeholders are university customers (Raaper 2019). Students, on the other hand, are the principal recipients of services offered by HEIs (Abdullah 2006b; Annamdevula and Bellamkonda 2016). Students regularly analyze service quality at higher education institutions to choose which university to attend (Shahijan, Rezaei and Guptan 2018). According to the Union (2017), HEIs should focus on improving students' skills, focusing on social issues, encouraging innovation, and reviewing performance management systems to reward successful practices. Students have been observed leaving educational institutions due to a lack of skill sets and competencies (H.B.R. 2019). Higher education institutions are expected to deliver quality education and services to the most vulnerable (Union 2017) and universities should maintain constant contact so that difficulties related to innovation, can be overcome collaboratively. As a result, they are enhancing their reputation, branding, and business image. Students are given opportunities to advance their academic careers through lifelong learning, which allows them to improve their knowledge and skills per community requirements and set goals (Bank 2010). For many years,

universities have competed with one another. To achieve a competitive advantage, higher education institutions must create effective and unique strategies to attract, retain, and build strong ties with students (Ilias *et al.* 2008). In early 2020 when the world was suddenly hit by the COVID-19 virus HEIs suffered greatly. Universities were compelled to close, and students were not permitted to return to campus. Since then, major developments in higher education have occurred (Hossain *et al.* 2020). Universities were forced to use online and mixed learning approaches to maintain social distance. This resulted in significant costs for HEIs due to the numerous upgrades that were required for online learning and teaching to take place.

2.2 Information Technology Technical Support Services

In universities, both academic staff and students demand technical assistance for the utilization of e-learning technology, such as Moodle (Raphael and Mtebe 2016). Academics require technical help to ensure that they have access to the materials they need and have been trained in the skills required to integrate technology into their teaching and assessment. Students require technical support to get the knowledge and skills needed to complete their studies successfully. Technical support is an important characteristic that encourages people to accept technology ((Sánchez, Hueros and Ordaz 2013). To provide technical support services, many different technologies are used, including WhatsApp online assistance Al-Sofi (2021), MS Teams support Malkawi, Bawaneh and Bawa`aneh (2021), help service Stewart *et al.* (2013), faxes and phone calls (Ralph 1991). Technical support services involve helping staff and teachers with technology needs, procurement services, program assistance, software, and hardware debugging, assisting students in computer laboratories, and maintaining computer labs for students to utilize. Help desk support is also provided via technology assistance, which involves answering students' questions and aiding with various technological concerns (Stewart *et al.* 2013).

2.3 Service Quality

Service quality is an assessment of how good a provided service authorizes a student's expectation (Saleem *et al.* 2017; Kandeepan, Vivek and Seevaratnam 2019). Higher education institutions (HEIs) around the world have learned that offering great service quality to students is the key to success in a competitive market (Nguyen *et al.* 2020). Similarly, Afthanorhan *et al.* (2019) adds that if student expectations and perceptions of service delivery exceed the expected service, potential students are more likely to enroll at an institution. According to Abdullah (2006b) student happiness is an important factor that can lead to the success of a university and can be used to improve perceived service quality. Students are the recipients of these services, hence it is critical to monitor service quality regularly to maintain the services given (Islam and Himel 2018).

2.4 Service Quality Measurements

Measuring the service quality that is provided is an important aspect because as providers of services, one might assume that services are of high quality. Therefore, HEIs must employ some sort of evaluation technique that will allow them to regularly assess the degree to which they satisfy or exceed students' needs. According to Arora and Narula (2018) measuring service quality allows one to make comparisons between before and after changes, it can also help in identifying quality-related problems which can then be used to establish high levels in service deliveries. There have been several attempts Azam (2018); (Huliatunisa *et al.* 2022) to examine service quality, but no consensus has been achieved on the idea of measurement in this context (Singh and Khanduja 2010). The SERVQUAL (Service Quality) framework was developed by Parasuraman, Zeithaml and Berry (1988) to measure service quality based on student perceptions. Ten service quality (SERVQUAL) components were found through extensive research by Parasuraman *et al.* (1985) and include tangibility, reliability, responsiveness, competence, credibility, communication, security, access, courtesy, and knowing the client (student). The service quality components were further condensed to five: tangibility, reliability, responsiveness, empathy and assurance.

The SERVQUAL model was developed on the premise that only experience can accurately assess the quality of services. As a result, service quality is defined as the distinction between what clients anticipate and what they receive. According to the disconfirmation paradigm, when Expected Service (ES) exceeds Perceived Service (PS), the quality of the service is poor, when ES exceeds PS, the quality of the service is outstanding, and when ES equals PS, the quality of the service shows that satisfaction has been obtained. However, Cronin and Taylor (1992) criticized the SERVQUAL model and proposed the Service Performance model (SERVPERF). In contrast to SERVQUAL, which focuses on both customers' expectations and perceptions, the SERVPERF model is a performance-only approach to evaluating service quality. It includes the five SERVQUAL aspects. They argued that evaluations should focus on the attitudes that customers develop after receiving services. When contrasting the SERVPERF model with the SERVQUAL model, Cronin and Taylor (1994) further demonstrate that the SERVPERF model explains the variations in an overall measure of service quality. Cronin and Taylor (1992) tried to address the bottlenecks of the SERVPERF model. Abdullah (2006a) developed the Higher Education Performance (HEdPERF) model that comprises five dimensions including: program difficulties, reputation, access, and non-academic factors. The study claimed that the HEdPERF scale would provide greater measurements, more accurate estimates of service quality, and more authentic material. However, since it is a single sector-based model it is too restrictive and is inconsistent (Brunson 2010).

2.5 Service Quality Models

The service quality model was created to assist firms in identifying factors that influence customers' negative views of service quality. By addressing these bad elements organizations can improve the quality of service and thus can gain a competitive edge. Over the years, multiple service quality models (Martilla and James 1977; Grönroos 1984; Parasuraman *et al.* 1985; Haywood-Farmer 1988) have been developed. Some of the developed service quality models will be briefly reviewed in this section.

2.5.1 Haywood-Farmer's Model

A service quality model proposed by Haywood-Farmer (1988) reveals that a service organization such as HEI is of high quality if customer preferences and expectations are continuously being met. Services are made up of basic attributes of physical procedures, processes, and facilities; people's behavior and professional judgment with many aspects as in Figure 2.1. The model also implies that concentrating too much on any one of these aspects will lead to disaster.

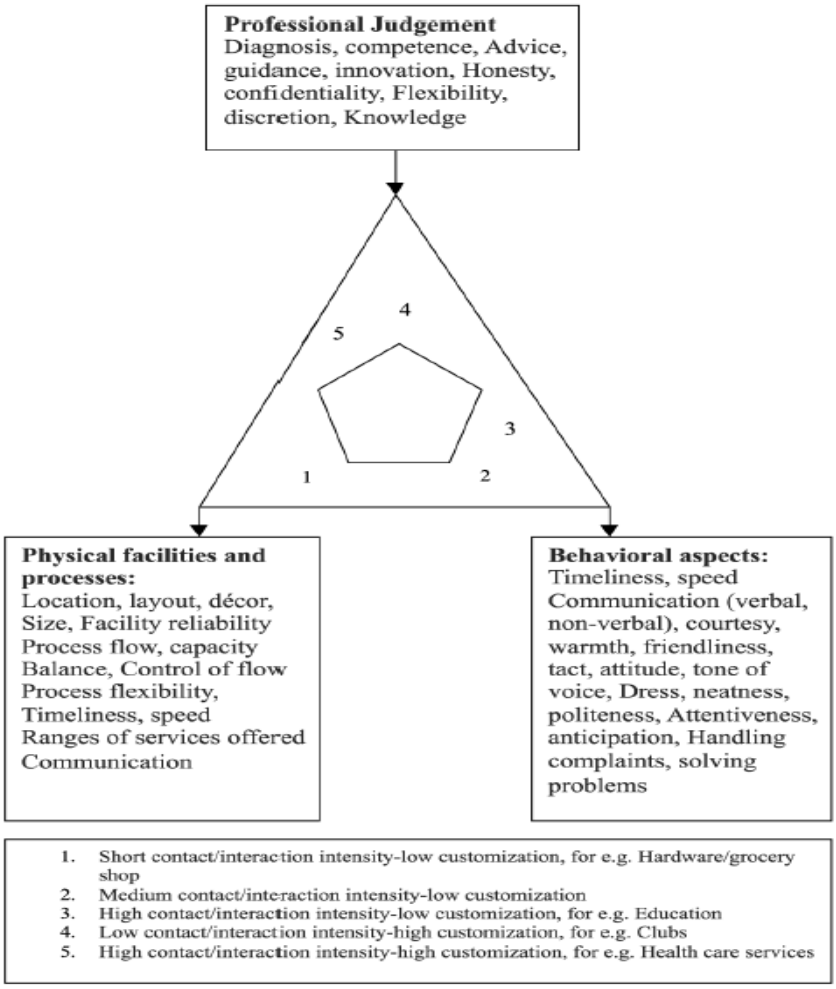

Figure 2.1. Haywood-Farmer's Model

2.5.2 Importance – Performance Analysis Model

The SERVQUAL model by Martilla and James (1977) served as the foundation for the Importance-Performance Analysis (IPA) model (Figure 2.2). Later, this model was modified by O'Neill and Palmer (2004) to fit the needs of the education industry. Even while this model simply considers performance, it also considers the relative importance that customers accord to each of the service quality characteristics. This concept is practical since it combines perceptions of the real performance of past, present, and future students. A separate hue is used to symbolize each of the model's four quadrants, which show concurrent interactions between importance and performance that are either high or low.

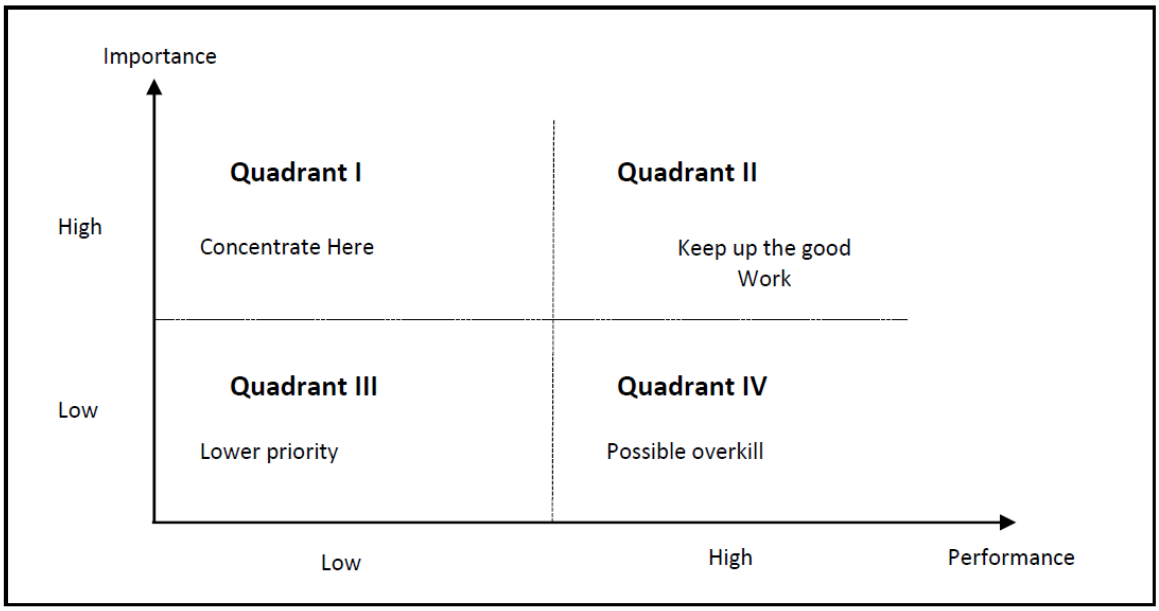

Figure 2.2. IPA Model

2.5.3 SERVQUAL Model

SERVQUAL is a service quality measurement scale that was created by (Parasuraman, Zeithaml and Berry 1988) and is demonstrated in Figure 2.3. This approach tries to offer a more exact standard by which to gauge service quality. It is the most well-known and frequently utilized model across all industries because it was the first service quality model ever developed. According to Parasuraman, Zeithaml and Berry (1991) service providers should regularly monitor clients' views of service quality, spot any inconsistencies in the service quality being offered, and implement the appropriate corrective measures to raise the level of service quality. This resulted in the creation of the Gap Analysis Model as shown in Figure 2.3, in which the variables Q, E, and P represent quality, customer expectations, and overall service provider performance, respectively. Customer happiness is therefore correlated

with the caliber of the services offered. The SERVQUAL Model is displayed in Figure 2.3. Each of the gaps will be described below.

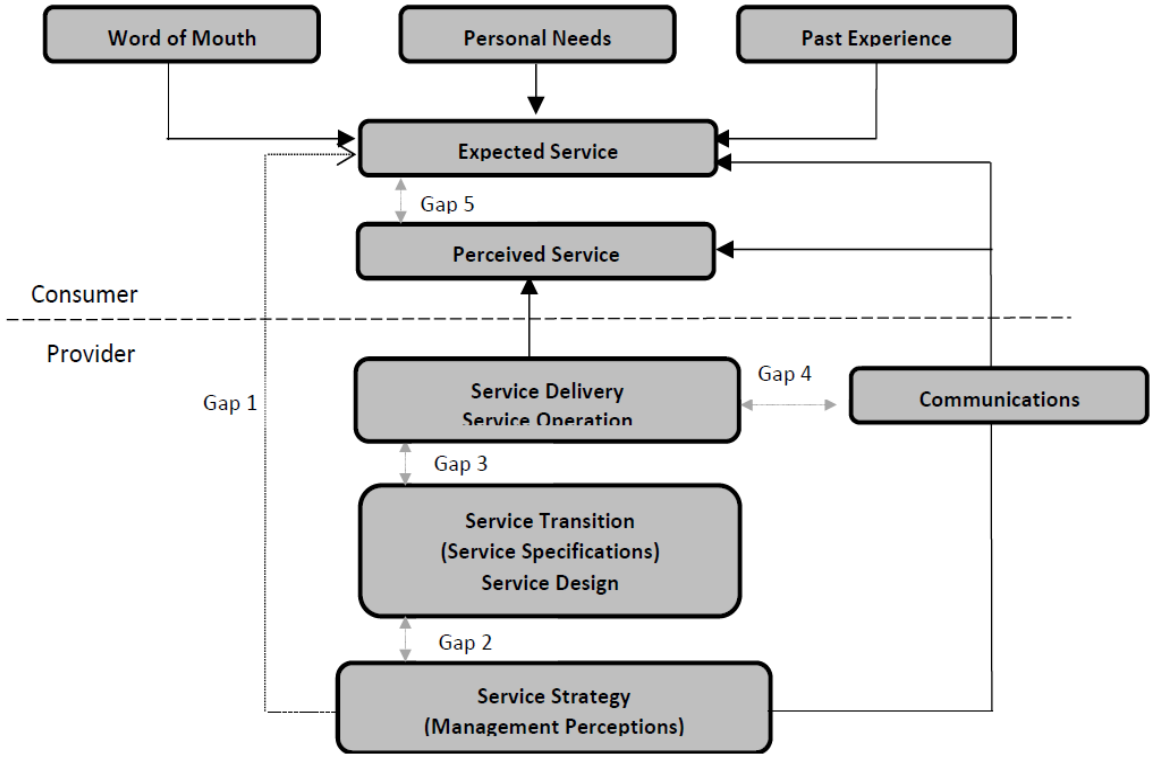

Figure 2.3. SERVQUAL Model
Source: Parasuraman *et al*. (1985)

Gap 1: Management's incorrect assessment of what customers anticipated from the service. referred described as the understanding gap occasionally.

Gap 2: Management perceptions: Management opinions regarding customer requirements and service standards. Occasionally referred to as the standards gap.

Gap 3: Service Quality Specifications: The intended service standards of management and the actual service provided. known as the service performance gap at times.

Gap 4: Service Delivery: There is a discrepancy between the way services are provided and how they are advertised to clients. referred to as the communications gap at times.

Gap 5: Expected Service: Judging clients based on the caliber of services is referred to as the apparent service gap at times. The most significant gap, which is a result of the first four gaps, is this one. As a sign of how customers use each component in their evaluation, Gap 5 is connected to the service quality dimensions (Parasuraman *et al.* 1985). Additionally, the original list of ten service

quality dimensions was condensed to just five: reliability, responsiveness, assurance, and empathy, with 22 corresponding statements.

2.5.4 Lehtinen and Lehtinen Model and Grönroos Model

Lehtinen and Lehtinen (1982) developed a service quality model with three dimensions: interaction quality, physical quality, and corporative quality. Interactive quality refers to communication between the client and the service provider. The physical quality of the service is linked to its tangible components. Customers' behavior reflects their expectations of a service provider's corporate excellence. The consistency of physical and interactive quality is often lower than that of corporate quality.

Grönroos (1984) created a service quality model that defines service quality as the discrepancy between what customers expect in terms of service and what they receive (Figure 2.4). Only performance results are used in this model to gauge service quality. Three dimensions make up the Grönroos service quality model: technical quality, functional, and image. The service the consumer receives from the business is of a technical quality as a result of engagement. This service is delivered in a functionally-quality manner. When a company's reputation affects customers' expectations, that is called an image. Utilizing the technical and functional components of quality that produce a perceived level of service makes it possible to project an image.

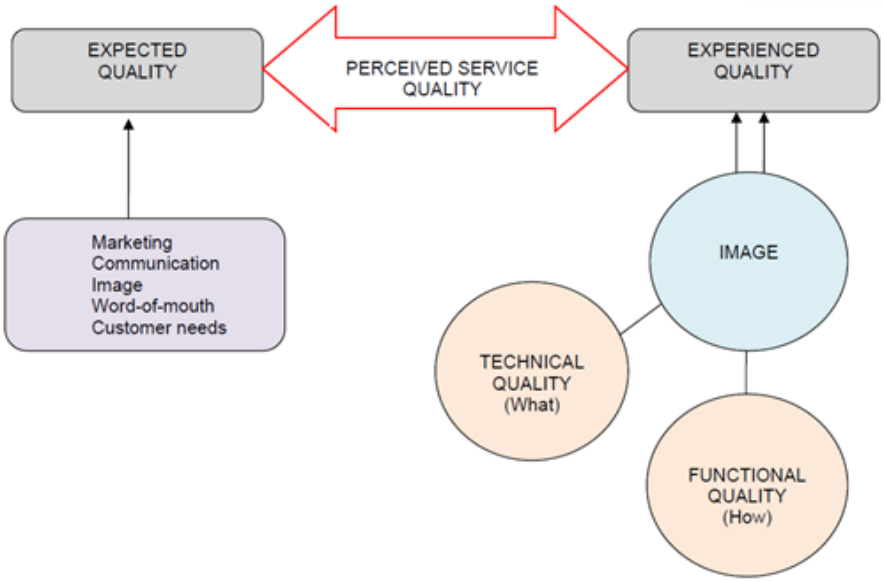

Figure 2.4. Grönroos Model

2.5.5 SERVPERF Model

Cronin and Taylor (1992) built the service performance model (SERVPERF) from the SERVQUAL model. This model is used as an alternative to the SERVQUAL model. Both of these models use the five service quality dimensions—tangibles, reliability, responsiveness, assurance, and empathy—to measure customers' expectations and perceptions, however, SERVPERF only concentrates on the SERVQUAL model's performance-based (customers' perception) component. The SERVPERF model, which supports the performance-based components in evaluating service delivery, is based on the premise that as services are physically received, consumers' expectations alter (Boshoff and Plessis 2009).

2.5.6 HEdPERF Model

By altering the SERVPERF model, the Higher Education PERformance (HEdPERF) instrument for gauging service quality was created by (Abdullah 2006a). Access, reputation, understanding, program difficulties, academic aspects, and non-academic elements are the six dimensions of this approach. The HEdPERF model's drawback is that it exclusively focuses on students as the main customers in HEIs, although other groups must also be catered to. Access includes approachability, availability, personnel contact ease, and the practicality of services provided (Brochado 2009). The value of projecting a professional image is referred to as reputation. The ability of the service provider to comprehend the demands of the students is referred to as understanding. Program concerns allude to how crucial it is for HEIs to provide a broad selection of respectable academic programs with flexibility in their structure and curricula. Academic elements relate to duties that academic staff must carry out to guarantee that students have access to the relevant study materials to support their academic endeavors. The administrative division of HEIs is responsible for giving students the resources they need to finish their studies, which is the last non-academic aspect to be discussed.

2.5.7 Other Service Quality Models Developed

Other service quality models were created (Chatterjee, Ghosh and Bandyopadhyay 2009; Senthilkumar and Arulraj 2010) and implemented in the higher education sector in addition to the ones already mentioned. Brogowicz, Delene and Lyth (1990) synthesized the service quality model based on a gap analysis that acknowledges that a consumer may not have used a service directly but may have learned about it from others or via other means of communication. It takes into account three variables as potential effects on technological and functional prospects: firm image, external influences, and traditional marketing operations. Boulding *et al.* (1993) created the dynamic process model to help service providers better grasp the importance of service delivery and consumer expectations for their businesses. Teas (1993) felt that the disconfirmation model has conceptual,

theoretical, and measurement issues, so he produced the assessed performance and normed quality model. He emphasized the following issues with the SERVQUAL conceptual definition: the value of the probability specification in the evaluated performance (EP) measurement, the theoretical justification of expectations in the measurement of service quality, and a link between service quality and customer satisfaction or dissatisfaction.

The two dimensions were functional quality and technical quality, which integrated tangibles and service delivery (Grönroos 1984, 1988). This was used by Rust and Oliver (1994) to create a three-dimensional model, which they named the three-component model. They did this by giving tangibles their unique dimension. The information technology alignment paradigm, created by Berkley and Gupta (1994) connects a company's service and information methods. This model was created because most IT organizations, if not all of them, are typically more concerned with increasing productivity and efficacy than they are with enhancing customer service and long-term customer efficiency. To gauge service quality in the retail industry, Dabholkar (1996) created the retail service quality scale model. It has five components: physical aspects (such as store layout and appearance), reliability (staff keeping promises), problem-solving (such as store staff handling customers' complaints), policy (such as operating hours and stores' policies on stock quality), and interpersonal aspects (such as helpful and courteous employees). The goal of Spreng and Mackoy (1996) model of perceived service quality and satisfaction was to improve comprehension of the concepts of perceived service quality and customer satisfaction. The impact of expectations, perceived performance desires, intended congruency, and expectation disconfirmation on total service quality and client pleasure is emphasized.

In a large service corporation, the factors that affect internal customers' and internal suppliers' perceptions of service quality were evaluated. In terms of service quality, Brady and Cronin (2001) tried to integrate the theories underlying Grönroos's model Grönroos (1984) with the Gap Model (Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1988, 1990). The interaction quality, physical environment quality, and outcome quality are the three dimensions of this model. Each of these dimensions has three sub-dimensions, and the perception of each dimension is formed by how frequently the sub-dimensions are evaluated. Total service quality perception is the result of the shared perception from all these dimensions. The online banking model was created to examine how service businesses can continue to offer their clients high-quality services even when those clients are far away (Broderick and Vachirapornpuk 2002). Zhu, Wymer and Chen (2002) explore the relationship between IT-based services and consumer perceptions of service quality in this IT-based model. A e-Service quality model was put forth by (Santos 2003). Concerning achievements and failures, this model sought to assess the service quality of the electronic commerce sector. By modifying Grönroos's model, Kang and James (2004) created a new model of service quality that

made it crystal obvious that to gauge an entity's view of overall service quality, functional quality, technical quality, and business image must be measured.

The fairness idea, according to Carr (2007), is absent from all SERVQUAL measuring scales. FAIRSERV has been incorporated into the SERVQUAL measurement system by (Carr 2007). Customers will evaluate fairness as well as the caliber of the services offered (Carr 2007). No one should be given preferential treatment; all customers expect to be treated fairly. According to Carr (2007), customers evaluate service quality not only by comparing it to multidimensional fairness standards such as procedural, informational, distributive, interpersonal, and complete fairness, but also by the SERVQUAL dimensions of tangibles, responsiveness, reliability, assurance, and empathy.

2.6 Service Quality Evaluation Models for HEI

The success of higher education institutions is greatly influenced by the quality of the services provided. In a variety of industries, including banking, retail, communication services, healthcare, etc., numerous studies on service quality have been conducted. Numerous researchers (Ramsaran-Fowdar 2007; Saravanan and Rao 2007; Rashid and Jusoff 2009; Kumar, Kee and Charles 2010; Quin, Prybutok and Zhao 2010) have created evaluation models over the years to pinpoint the weak areas that HEIs should concentrate on to provide high-quality services. Higher service standards would help educational institutions draw in more students. A handful of these evaluation models will be briefly described in this section. Raju and Bhaskar (2017) developed a conceptual model of service quality in higher education (Figure 2.5). This model can be used as a starting point by the government and those who support higher education to strengthen areas that have been identified as insufficient for delivering high-quality instruction.

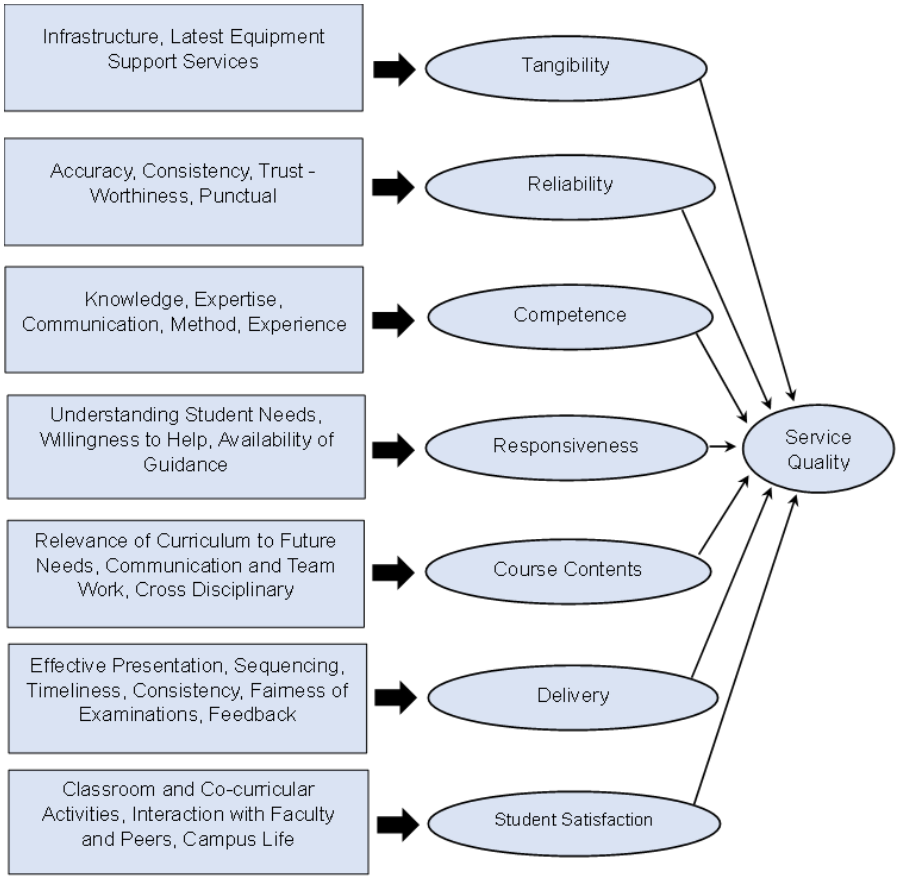

Figure 2.5. Conceptual Model

Hajdari (2019) used a survey with students at an Albanian public university to gauge the standard of the services provided by the institution using the SERVQUAL model. The study's findings indicated that students weren't satisfied with the reliability component, which measures staff members' desire to support pupils. In his research, Green (2014) discovered that employees and students at the Durban University of Technology's Riverside and Indumiso campuses had different expectations of services. The SERVQUAL technique was utilized by Saliba and Zoran (2018) in the study analysis to evaluate the level of service provided by HEIs. The study's findings showed that students' expectations of service quality were substantially lower than those that were met. The dimensions employed in the investigation are shown in Figure 2.6.

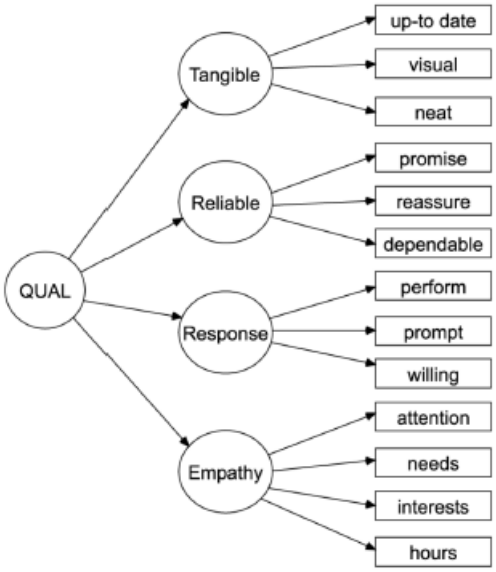

Figure 2.6. SERVQUAL Model
Source: Saliba and Zoran (2018)

Nanaj (2006) wanted to evaluate the level of customer service at a university in Tirana, Albania. The perceptions of the students regarding the caliber of the services are unknown to the Albanian HEIs. The majority do not have procedures in place to obtain student input to raise the caliber of the current services. Kobero and Swallehe (2022) examined customer satisfaction and service quality at a university in Tanzania as part of the analysis. The SERVQUAL model was applied. The findings indicated that the students were dissatisfied with the general caliber of the services offered. Schijns (2021) used the National Student Enquiry (NSE) tool to analyze and assess how students perceive the quality of the services they receive from higher education institutions, as well as to determine how this affects students' satisfaction and willingness to recommend the institution. The study was carried out at Open Universiteit in the Netherlands (OUNL), a public online university. The conceptual model employed in the study is depicted in Figure 2.7.

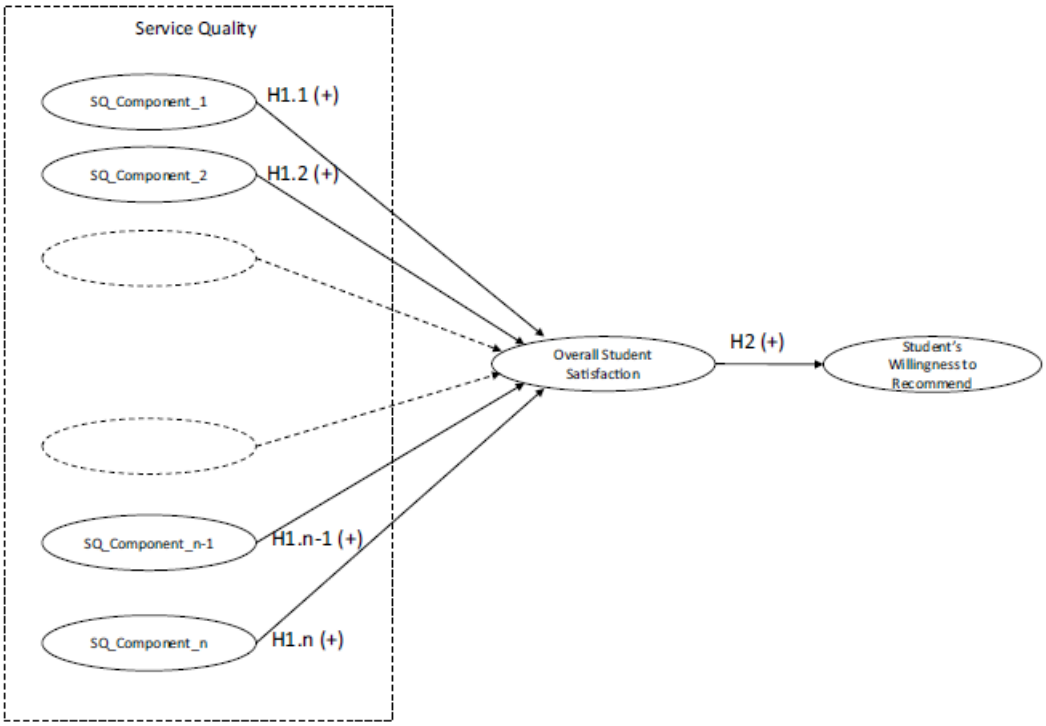

Figure 2.7. Conceptual Model
Source: Kang and James (2004)

The SERVQUAL approach was employed by Adam (2019) to assess the caliber of the services provided at a university in Sudan. A methodology was created by Senthilkumar and Arulraj (2010) to assess the level of service provided by higher education institutions in India. Service Quality Measurement in Higher Education in India (SQM-HEI) is the name given to the model. In his research, Shah (2013) examined the connections between customer satisfaction aspects and service quality in Pakistani higher education institutions. The SERVQUAL approach was employed. The SERVQUAL approach was employed by Aboubakr and Bayoumy (2022) to assess how well-received educational services were by students at an Egyptian institution. Ibrahim, Rahman and Yasin (2012) looked into how Malaysian students felt about the service quality at public and private technical education vocational training institutes (TEVT). Physical facilities, training tools, training delivery, instructor, campus atmosphere, curriculum, reliability of service, support services, support personnel, and library were utilized as the ten service quality dimensions. Using the five SERVQUAL dimensions, Yousapronpaiboon (2014) investigated the service quality of Thailand's higher education institutions.

Mattah, Kwarteng and Mensah (2018) employed principal component analysis in the study to identify the elements that affect service quality from the viewpoint of students at an HEI in Ghana. The elements identified were academic services and facilities, lecturer quality and academic instructions. Students were dissatisfied with the quality of the facilities provided. The question of whether demographic characteristics affect student happiness and service quality was tested by (Ilias *et al.*

2008). The five dimensions from Parasuraman's SERVQUAL model were applied in this study. The result was that demographic factors did not affect student happiness and service quality. Thapa (2022) investigated how students in tertiary education in Panauti, Kavre and Nepal viewed the service quality by adopting the SERVQUAL dimensions. The characteristics that affect student satisfaction with the use of learning management systems (LMS) during the COVID-19 pandemic were examined by (Alzahrani and Seth 2021). Social cognitive theory, expectation confirmation theory, and DeLone and McLean's IS success model were all integrated into this study. At a university in Saudi Arabia, the SERVQUAL model was employed to gauge students' perceptions of service quality (Sadiq Sohail and Shaikh 2004). Ahmad and Kawtharani (2021) did a study to compare the actual service quality delivered to students at an Iranian institution to the expected service quality. The SERVQUAL model was put into practice. The Higher Education Performance-only (HEdPERF) model created by Abdullah (2006c) was utilized by the researchers Ahmad and Kawtharani (2021) to assess the level of services offered at a university in Lebanon from the perspective of the students. Using the SERVPERF paradigm, Onogo (2019) investigated how foreign students in Indiana and Michigan assessed the quality of the services they received. The finding of the study revealed that reliability, tangibility, and empathy showed a significant proportion in the association between service quality and satisfaction, then students were satisfied with the quality of services offered by non-academic sectors. In Punjab, Pakistan's HEIs, Malik, Danish and Usman (2010) used the structural equation modelling technique (SEM) to reveal the effect of service quality on students' satisfaction. The study's findings revealed that students had a respectable degree of service quality.

2.7 Service Quality of Technical Support in Higher Education

As universities become more student-centered, it is increasingly important for them to focus on the quality of what students expect from the university (Ilias *et al.* 2008). Universities are accountable for providing an ideal and high-quality educational experience for the students. Improving the standard of IT assistance services attracts and retains students, as well as encourages them to refer the school to future students (Molina, Gavilán-Martín and Álvarez-Herrero 2021). As a result, it is critical to assess the quality of support services that students receive, especially since the COVID-19 pandemic prompted many HEIs to teach online. The technical support platform is required to give students and staff prompt and correct responses (Molina, Gavilán-Martín and Álvarez-Herrero 2021). To establish the quality of technical support services, some kind of evaluation must be performed, which is done using specified criteria. Quality requires measurement, and comparison with a suitable source, including a decision regarding the object's suitability in relation to the chosen reference (Bucarey *et al.* 2021).

The quality of technical services, according to research conducted by Bucarey *et al.* (2021) is to measure student satisfaction regarding the effectiveness of remote instruction in academic

institutions. Al-Juda (2017) found that technical help was reasonably given via e-cards on the e-learning web portals in his research to analyze students' perceptions of utilizing the e-learning system in a Saudi institution. Because of the COVID pandemic, an Egyptian university switched from traditional to virtual distance instruction. The outcome was that learners felt dissatisfied regarding assistance received because the IT personnel was frequently unable to assist them in resolving the issues (Said 2021). Muthamia (2016) examined the relationship between university service quality and student satisfaction in Kenya using the case study of the United States International University. According to the findings of the study, United States International University has professionally qualified technicians who have the essential abilities to assist students in completing their studies.

2.8 The Need for Information Technology Support Services

Support services are the additional help that students receive that include but are not limited to help desk services, academic advising, library services, financial aid services, and technical support services. It is the key element in enhancing students' learning experiences (Lee *et al.* 2011). Kumtepe *et al.* (2018) support services as a whole set of services that are provided to students, academics, administrative, technical staff, etc., to use the institutions' resources effectively to create quality learning. Simmons (2013) states that support is needed to help students meet their learning outcomes, to help them cope with the demands of student academic life, and to complete their studies. Rovai and Downey (2010) and Rotar (2022) emphasize that student support promotes student satisfaction. Floyd and Casey-Powell (2004) and Smith (2007) complement that due to the increase in student enrolment at higher education institutions, there is a growing demand for student support services. Hall (2010) states student support services are needed to provide assistance and reassurance to academically disadvantaged students to make a smooth changeover into higher education life. Shikulo and Lekhetho (2020) state that student support services are critical at HEIs, in the ever-transforming distance education.

2.9 Student Satisfaction in Higher Education

Universities and other educational institutions have recognized the importance of student satisfaction in running an effective organization. University administrations are continually researching and improving on aspects that can increase student enrollment. These characteristics include but are not limited to, academic staff skills, faculty physical and social facilities, and department physical facilities (Malik, Danish and Usman 2010). Universities must analyze all of these elements to improve, hence delighting students and increasing student intake and retention (Ibrahim, Rahman and Yasin 2012).

Evaluating student satisfaction provides university administrators with a clear picture of students' expectations, needs, and feelings during service delivery (Xue, Zhao and Guo 2008). With these criteria identified, university administrations can improve the quality of services provided to students.

Service quality is essential for establishing and maintaining connections with prestigious clients (Ilias *et al.* 2008). Student happiness has been found in studies to boost student retention and the overall performance of institutions (Hung 2021). Higher education institutions have realized this and, as a result, place a greater emphasis on understanding and addressing students' needs and expectations. Existing students who are satisfied with the HEI's services will have a positive impact on the public and offer the educational institution a competitive edge. The main reason for students' withdrawal is an expectation that a postsecondary school cannot meet (Aldridge and Rowley 1998). One of the primary factors in students' decision to enroll is the assessment of university services (Price *et al.* 2003).

2.10 Student Satisfaction with Technical Support Service in Higher Education

Said (2021) conducted research to assess learners' contentment with the skilled assistance offered during COVID-19 at one of Egypt's institutions. The survey found that learners had been dissatisfied with computer assistance given since IT staff were not always available to assist them with technical questions. Similarly, Bucarey *et al.* (2021) discovered that technical support was not always available to assess students' happiness with digital changes in HEIs. Ansari *et al.* (2021) looked at students' experiences with distant learning and the help they got throughout the pandemic. The findings revealed that students were pleased with the technical assistance they received. Al-Sofi (2021) conducted research on student satisfaction with the e-learning process during the epidemic and discovered services that boosted satisfaction. The study found that students were satisfied with the WhatsApp and email technical services offered to them. Students were satisfied with the technological support services offered throughout the epidemic, according to research conducted by (Al-Juda 2017). Students received technical assistance through a variety of communication channels (direct calls, WhatsApp messages, and emails).

Avsheniuk *et al.* (2021) conducted a study to measure the level of satisfaction with English for specific purposes (ESP) students using online ESP learning courses at three faculties at the University of Kyiv in Ukraine. The survey found that students were satisfied with the online technological help obtained. It was discovered that technical support personnel’s presence is critical in online knowledge acquisition. Stewart *et al.* (2013) quality frameworks were investigated to discover whether or not support aspects were included. A case was examined to observe the implementation of online student support services. The outcome of the study showed that support services are accepted in frameworks and standards to assess and promote quality in online teaching and learning. Foerderer *et al.* (2021) performed a study on the experiences and perceptions of higher education students throughout the global pandemic. Students were satisfied as a consequence of the research because they were aware that online technical help was provided 24 hours a day, seven days a week.

2.11 Technique for Order Preference by Similarity to Ideal Solution

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is a multiple criterion choice-making technique that involves ranking a set of alternatives based on the proximity to an ideal solution (Wang, Thu Nguyen and Phan 2022). It determines the ideal solution by finding the option that is closest to the optimistic perfect outcome but farthest away from the worst possible outcome. Euclidean distance or other distance metrics are calculated (Balwinder and Prabhakar 2012). On the other hand, the Fuzzy TOPSIS method extends the TOPSIS method by considering the vagueness and uncertainty associated with decision-making (Musaad *et al.* 2020). Fuzzy sets are used to represent the decision criteria and alternatives. The membership values of the fuzzy sets represent the degree of satisfaction of the criteria. The Fuzzy TOPSIS method calculates the closeness coefficient of each alternative to the ideal solution by using fuzzy arithmetic operations.

In summary, while the TOPSIS method uses crisp values to represent the decision criteria and alternatives, the Fuzzy TOPSIS method uses fuzzy sets to represent them and considers the vagueness and uncertainty in decision-making (Musaad *et al.* 2020).

2.12 Empirical Studies on Service Quality in Higher Education

Investigative studies regarding educational institutions' facility standards have become increasingly important in recent years, as the competition for students has become more intense, and student satisfaction has become a crucial factor in determining the success of universities and colleges (Nguyen *et al.* 2020). Service quality is a crucial aspect of higher education, as it affects student retention, recruitment, and the overall reputation of the institution (Ibrahim, Rahman and Yasin 2012) (Swecker, Fifolt and Searby 2013).

The most widely used tool for measuring service quality in higher education pertains to the SERVQUAL instrument (Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1988; Prasad and Madhavi 2014). The SERVQUAL instrument has been used in numerous investigative studies on educational institutions' service standards, providing insights into the factors that affect student satisfaction and loyalty (Mulyono *et al.* 2020). Research regarding service excellence evaluation at educational institutes has revealed that facility excellence is a key determinant of retaining students and enjoyment (Mulyono *et al.* 2020). Factors such as the quality of teaching, available supplies, responsive staff, and premise environment have a substantial influence on student fulfilment.

Additionally, studies have found that service quality is positively related to student retention and academic achievement (Ibrahim, Rahman and Yasin 2012; Hung 2021). The most widely used model for assessing service quality in higher education is the SERVQUAL model, founded by (Parasuraman *et al.* 1985). In addition to the SERVQUAL model, other models and scales have been developed to

assess service quality in higher education, including the HEdPERF model, which was developed by (Brady and Cronin 2001).

Examples of studies include, Hassan *et al.* (2020) investigated the interceding effect scholar pleasure has in excellent service and learner retention in Technical and Vocational Education and Training (TVET) higher learning institutes. Purposive sampling and Smart PLS 3.0 were used to analyze questionnaires. According to the PLS-SEM study, there was a direct and significant association between service quality and student loyalty. A mediating test was performed, and it was observed that there is some mediation of student satisfaction between service quality and loyalty. It showed that student satisfaction serves as a partial mediator between service quality and student loyalty.

Similarly, Doan (2021) investigated the relationships between the quality of service, academic environmental policies, pupil contentment, and dedication of students in Vietnam. An empirical approach was conducted whilst information had been acquired via web-based surveys. According to the findings of the study, quality of service had a significant effect on student contentment and dedication. Hoque *et al.* (2023) applied the SERVQUAL model to evaluate learners' happiness at learning institutes in Bangladesh. The study showed that an increase in learners' joy can lead to learner devotion.

2.13 Empirical Studies on IT Technical Support Services

Empirical studies on IT technical support services have become increasingly important in recent years, as businesses and organizations increasingly rely on technology to carry out operations. Technical support services play a crucial role in ensuring the smooth functioning of IT systems and reducing downtime caused by technical issues (Sánchez, Hueros and Ordaz 2013). Empirical studies on IT technical support services include Bucarey *et al.* (2021) attempted to improve online learning services at learning institutions and assess learners' satisfaction with remote teaching and learning. A model was proposed to quantify student satisfaction in terms of technological quality, teacher quality, and service quality in the study. The findings indicated that technical support platform should give students prompt and correct responses.

Said (2021) explored the effect of the abrupt switch from traditional to remote studying at an institute in Egypt during the lockdown. The survey assessed learners' and teachers' satisfaction with online learning during the pandemic in terms of computer administrative assistance offered by the institution. Quantitative and qualitative research methods were utilized. According to feedback, students should have access to excellent and responsive IT technical assistance and troubleshooting services, especially during exams. There should be assistance 24/7 via calls, emails, and chat. Learners claim to be dissatisfied with the college's tech assistance services, claiming that the IT professionals were never available to help them with portal access issues.

At Saudi higher education institutions, Aziz and Alluhaidan (2022) presented an Information Technology Service Quality (ITSQ) measurement. Five ITSQ qualities are distinguished: dependability, responsiveness, assurance, empathy, and tangibility. A 44-item measure was utilized to quantify these qualities, which they tested empirically. The study's findings indicated that the scale was a viable and trustworthy method for measuring ITSQ in higher education institutions. A well-established high-quality ITSQ, according to the authors, is crucial for increasing the quality of higher education institutions. The proposed scale intended to address this issue by offering a mechanism for monitoring and improving ITSQ at higher education institutions. The authors conclude by recommending that higher education institutions use the suggested scale to assess the ITSQ and identify areas for improvement.

Similarly, Pursan, Adeliyi and Joseph (2023) conducted a study to find and classify the important critical elements for IT technical support in higher education. The systematic literature study was used to uncover 81 important critical factors from 100 research studies. Principal component analysis (PCA) was employed to extract the most essential ones. The findings resulted in the identification and ranking of 25 major components. This study provided important information by highlighting characteristics that can be utilized to assess areas in educational institutions that require ongoing and specific attention to generate high student satisfaction, ensure future success, and acquire a competitive edge. These indicators might help HEI management judge an institution's success or failure in technical support offered to students and student satisfaction.

2.14 Empirical Studies on Fuzzy TOPSIS Method

Several studies on Fuzzy TOPSIS have been conducted including those by (Jamal, Khalif and Mohamad 2021; Alshahrani *et al.* 2022; Wang, Thu Nguyen and Phan 2022; Xu *et al.* 2022; Azaman *et al.* 2023).

Jamal, Khalif and Mohamad (2021) proposed a new methodology to solve multifaceted problem solving with fuzzy TOPSIS method and fuzzy entropy. An empirical study of working women's subjective well-being was used to demonstrate the proposed methodology. The goal was to assess and discover which alternatives had the biggest impact. The survey included forty female respondents, and the choices were ranked depending on the criteria chosen. The ranking displayed the options that had the greatest impact on most of the working women's quality of life. Alshahrani *et al.* (2022) set out to investigate and debate information technology risk management processes. To examine and prioritize numerous IT risk indicators, empirical inquiry based on multi-criteria decision-making was employed. Among the indications revealed, *technology* was ranked as the biggest source of risk within a corporation.

Wang, Thu Nguyen and Phan (2022) proposed using the Entropy-TOPSIS technique to analyze the performance of autonomous colleges in Vietnam. The Entropy strategy was utilized to weight the criteria, and the TOPSIS method to rank private colleges depending on the performance. To assess the link between rank-ordered variables, Spearman's rank correlation coefficient and ANOVA are applied to compare the criteria between institution groups. Colleges were ranked based on how well they did in training.

Xu *et al.* (2022) attempted to rate the joy of different institutions using the Fuzzy TOPSIS technique utilizing the cloud-based concept. Findings suggested that 60% of learners agreed on virtual instruction post-pandemic. Azaman *et al.* (2023) used the Fuzzy TOPSIS approach to identify and assess the significant aspects of educational institute selection. Academic reputation, program quality, employment prospects, location, and cost were factors influencing an organization's decision. The findings provided insight into the aspects that learners evaluate when deciding on an educational institute. These findings can aid learning institutions establish more effective marketing and recruitment tactics, as well as assist learners in reaching better decisions.

2.15 Systematic Literature Review

To obtain the pertinent data, this investigation used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) technique proposed by (Moher *et al.* 2009). PRISMA is one of the best strategies for assisting researchers in conducting reliable systematic reviews and meta-analyses and reviewing a structure like a road map. This method is popular in the systematics literature and has been widely used in a range of studies (Moher *et al.* 2010; Moher *et al.* 2015; Shamseer *et al.* 2015; Stewart *et al.* 2015; Hutton, Catala-Lopez and Moher 2016; Thompson, Joseph and Adeliyi 2022). The researcher can summarize and assess the scientific literature that can be collected using a structured approach that is based on objectives that are created so that different authors can use them in a systematic review, which gives substantial evidence (Gopalakrishnan and Ganeshkumar 2013).

The PRISMA framework is divided into four stages: Researchers begin the *identification* stage by conducting a thorough and systematic search of relevant literature sources, such as academic databases, journals, and other resources. The goal is to find any potential studies that may be relevant to the study issue. This stage entails employing specified search terms and criteria to acquire a large number of preliminary records. The researchers analyze the titles and abstracts of the obtained records during the *screening* stage to see if they fit the predefined inclusion and exclusion criteria. At this step, research that does not fulfill the criteria is eliminated, while possibly relevant studies are advanced to the next stage. The researchers conducted a careful evaluation of the entire texts of the studies that passed the screening step during the *eligibility* stage. They thoroughly assess the

substance of these studies to verify they fit the particular criteria outlined in the protocol for the review. Studies that match the criteria may be included in the systematic review or meta-analysis. The final level of data selection is the *included* stage. The researchers construct a list of studies that have met all of the inclusion criteria and hence are included in the systematic review or meta-analysis. As part of the review process, these papers will be subjected to additional analysis and synthesis (Page *et al.* 2021).

Hence, this investigation searched for all published studies reporting on IT technical support services through a search of the literature. Identification of pertinent research, screening, and selection of those studies, eligibility, and inclusion stages were all completed following the PRISMA methodology.

2.15.1 *Identification:*

Scientific articles relating to IT technical support service key success factors in higher education institutions were published in scholarly journals listed on the SCOPUS database (368) and Science Direct (749). Databases were searched by using the keywords “key success factors”, “IT technical support services”, “higher education”, limited to years greater than 1985 and less than 2022, limited to “journals”, limited to “computer science” subject area and limited to the “English” language. The Next step of the PRISMA method is to remove duplicate articles.

2.15.2 *Screening:*

A review of articles relevant to IT Technical Support Service Key Success Factors in Higher Education, the articles were screened by analyzing the title and abstract. The articles were put into the Mendeley citation management software. From a total of 1,117 articles 303 duplicate articles were removed. Finally, 814 articles remain.

2.15.3 *Eligibility*:

Eligible criteria are needed to select appropriate articles Ahmadi *et al.* (2018), therefore articles are filtered based on inclusion and exclusion criteria as shown in Table 2.1.

Table 2.1 shows that only publications that satisfy the criteria are chosen; chapter books, brief reports, articles, non-English papers, and works from before 1985 are all excluded. In this instance, 25 items were eliminated since they did not meet the requirements and 789 articles are still present. Another 749 pointless articles have been eliminated at this point.

Table 2.1 Inclusion and Exclusion Criteria

CRITERIA	
Exclusion Criteria	
EC1	Papers in which only abstract is available.
EC2	Duplicate records.
EC3	Review and survey papers.
EC4	Papers not written in the English language.
EC5	Papers not relevant to IT technical support services.
EC6	Papers not applying PCA or Factor Analysis or SERVQUAL dimensions.
EC7	Papers not reporting sample size.
Inclusion Criteria	
IC1	Articles published in English.
IC2	Papers in Computer Science subject area only.
IC3	Papers relating to IT technical support service key success factors in higher education.
IC4	Journal papers only.
IC5	Papers between 1985 to 2022.

2.15.4 *Included*:

100 studies meet the inclusion criteria. The 100 studies that can contribute to this study are examined in this final step. The identified studies are carefully read through to extract and condense key information. The information gathered is used for this study. The flow of a database search using PRISMA is shown in Figure 2.8.

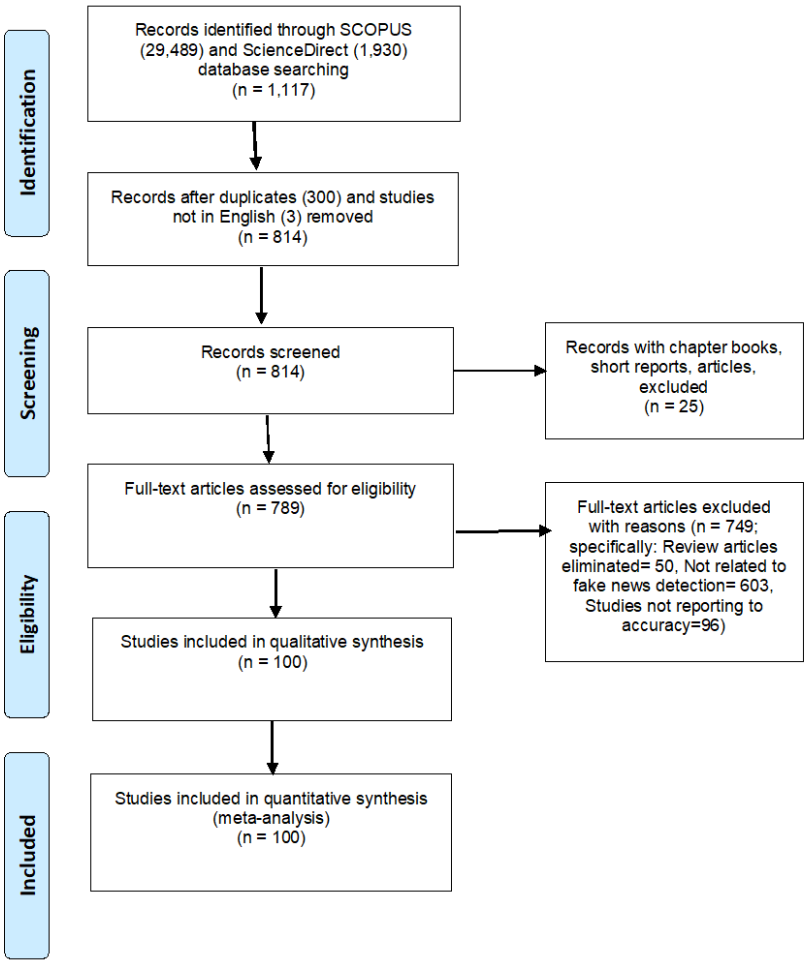

Figure 2.8. Flow Diagram of Database Search using PRISMA

2.16 Summary

This chapter examined the higher education institutions; duties performed by technical support personnel; the measurements of quality of service and models developed; the need for computer administrative assistance; student satisfaction, SERVQUAL, and Fuzzy TOPSIS methods. Finally, the PRISMA method is explained. The empirical studies for each have been explained and some examples are mentioned. The research methodology used to assess how satisfied higher education students are with the IT technical support services offered at the Durban University of Technology is covered in the next chapter.

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter presents the research framework comprising three modular approaches as shown in Figure 3.1 to accomplish the aim and objectives of this study. The first modular approach used Principal Component analysis to perform dimension reduction of the identified factors. From the identified factors, the researcher selected the five highest-ranked factors which were: tangibility, reliability, responsiveness, assurance, and empathy. The second modular approach used these five SERVQUAL dimensions to design the questionnaire, and finally, decision theory, in conjunction with Fuzzy TOPSIS, which is a multi-criteria decision-making method was utilized to rank the sub-criteria based on a set of criteria. It is used in this study to evaluate student satisfaction levels with IT technical support services based on multiple criteria, such as technical knowledge of the support staff, response time, and availability. This chapter also covers data collection, target population, instrument size, reliability, and validity. A research framework using the three modular approaches underpinning the study and the processes carried out by the researcher are illustrated below.

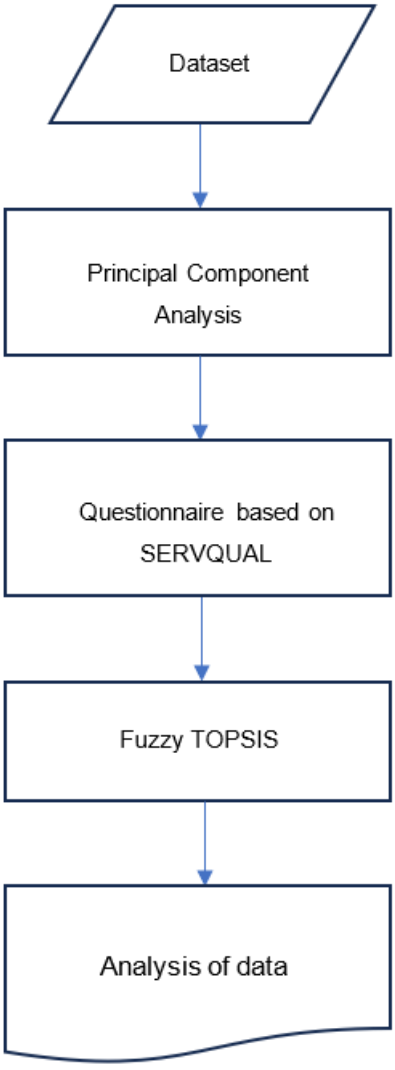

Figure 3.1. The Research Framework

3.1 Principal Component Analysis

Principal Component Analysis (PCA) is a statistical method used in data analysis and machine learning for dimensionality reduction and feature extraction. It aims to transform a dataset into a new coordinate system where the variability of the data is maximized along the principal components. These principal components are orthogonal to each other and are linear combinations of the original features. This study uses PCA to identify and rank the important success indicators for information technology technical support services in higher education institutions.

PCA consists of three key stages: dataset, data standardization and principal component analysis. Each stage is described as follows:

a. *Dataset*: The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) technique proposed by (Moher *et al.* 2009) was followed. The researcher was able to conduct a rigorous and transparent systematic review and provide a reliable summary of the available evidence that a total of 81 factors were extracted from 100 research studies for this study (refer to Section 2.15). They have been collected and given in numerical form to show the attributes of the discovered factors for further investigation.

Table 3.1 presents and describes the study dataset, which includes 100 quantitative examples and 81 qualitative cases for each element. PCA was used to analyze the dataset in order to show the factors and establish the weights of each element. To determine the transformation of the factors, the dataset was standardized into items of classes and attributes using the PCA approach known as scaling in R-Studio. The eigenvalue of a factor is the amount of total variance associated with that factor. Variables with eigenvalues greater than one are retained and considered crucial, indicating that the factor generates more common variance than unique variance (Shrestha 2021). Therefore, Kaiser criteria were used to calculate the number of PCS, which has a minimal eigenvalue of unity. Factors 1 through 81 were coded as @ ATTRIBUTE F1-F81 in the dataset, and their extraction was coded as @ ATTRIBUTE class PC 1-PC 100. The statistical approaches for assessing the transformed dataset were obtained using R-Studio version 22022.07.01 Build 554 and WEKA version 3.8.6. The contributions of several components were examined, and transformations were found among the factors with higher validation by applying these two statistical approaches. The qualities were ordered using the WEKA tool.

Table 3.1 Qualitative and Quantitative IT Technical Support Services (ITSS) Factors for PCA

ITSS FACTORS	NAME	DESCRIPTION	ADAPTED FROM SOURCE
F1	reliability	Student is assured that support staff to help resolve queries promptly.	(Owino *et al.* 2014; Yousapronpaiboon 2014; Kajenthiran and Karunanithy 2015; Saliba and Zoran 2018; Hajdari 2019; Ariyanto,

			Aima and Sari 2020; Mulyono *et al.* 2020; Twum and Peprah 2020; Yahaya, Asante and Alhassan 2020; Huliatunisa *et al.* 2022; Kobero and Swallehe 2022)
F2	responsiveness	IT technical support staffs' willingness to assist students and provide them with prompt service.	(Sadiq Sohail and Shaikh 2004; Owino *et al.* 2014; Yousapronpaiboon 2014; Kajenthiran and Karunanithy 2015; Asefi, Delaram and Deris 2017; Saliba and Zoran 2018; Hajdari 2019; Ariyanto, Aima and Sari 2020; Twum and Peprah 2020; Yahaya, Asante and Alhassan 2020; Huliatunisa *et al.* 2022; Kobero and Swallehe 2022)
F3	tangibility	Communication medium used to provide support services to students. Friendliness of staff.	(Yousapronpaiboon 2014; Kajenthiran and Karunanithy 2015; Asefi, Delaram and Deris 2017; Saliba and Zoran 2018; Hajdari 2019; Ariyanto, Aima and Sari 2020; Mulyono *et al.* 2020; Twum and Peprah 2020; Yahaya, Asante and Alhassan 2020; Huliatunisa *et al.* 2022; Kobero and Swallehe 2022)
F4	empathy	IT technical support staff give students personal attention and understanding of the students' specific needs.	(Yousapronpaiboon 2014; Kajenthiran and Karunanithy 2015; Asefi, Delaram and Deris 2017; Saliba and Zoran 2018; Hajdari 2019; Ariyanto, Aima and Sari 2020; Twum and Peprah 2020; Yahaya, Asante and Alhassan 2020; Huliatunisa *et al.* 2022; Kobero and Swallehe 2022)
F5	assurance	IT technical support staff being courteous to students as well as staff having the knowledge to answer students' queries.	(Yousapronpaiboon 2014; Kajenthiran and Karunanithy 2015; Asefi, Delaram and Deris 2017; Saliba and Zoran 2018; Hajdari 2019; Ariyanto, Aima and Sari 2020; Twum and Peprah 2020; Yahaya, Asante and Alhassan 2020; Huliatunisa *et al.* 2022; Kobero and Swallehe 2022)
F6	trustworthy and loyalty	Loyalty requires developing a solid relationship with students.	(Mulyono *et al.* 2020)
F7	commitment	Students' likeliness to contact the same technical staff for assistance in the future.	(Mulyono *et al.* 2020)
F8	competence	IT technical staff have the appropriate knowledge and skills.	(Yousapronpaiboon 2014)
F9	reputation	IT technical staff are consistent in terms of service delivery.	(Sadiq Sohail and Shaikh 2004; Mulyono *et al.* 2020)
F10	technical support staff	Timeliness and effectiveness of solution provided.	(Sadiq Sohail and Shaikh 2004; Lee *et al.* 2011; Al-Sofi 2021; Bucarey *et al.* 2021; Foerderer *et al.* 2021)
F11	communication material	Documents provided to students are easy to follow and are easily accessible and accurate.	(Abdullah 2006b; Owino *et al.* 2014; Mulyono *et al.* 2020)
F12	communication method	Effective use of modern online tools and services. The WhatsApp service used is reliable and easy to use. Technical staff are easily accessible by this service.	(Abdullah 2006b; Mulyono *et al.* 2020; Bucarey *et al.* 2021)
F13	location	Remote technical support provided is very convenient. Remote technical support is available 24/7.	(Abdullah 2006b)
F14	customer orientation	Student is very satisfied with the service provided.	(Voon 2006)
F15	competitor orientation	IT technical staff having competitive advantage over	(Voon 2006)

		others in terms of providing excellent service to students and knowledge of technical staff.	
F16	inter functional orientation	Inter IT technical department communication.	(Voon 2006)
F17	performance orientation	IT technical staffs' commitment on service.	(Voon 2006)
F18	employee orientation	IT technical staff choose to provide service excellence.	(Voon 2006)
F19	long term orientation	IT staff continuously improving on student services.	(Voon 2006)
F20	academic aspects	IT staff assist students with queries thereby increasing student academic performance.	(Owlia and Aspinwall 1996; Kristensen *et al.* 2000; Abdullah 2006b; Banahene, Kraa and Kasu 2018; Muhammad *et al.* 2018; Ali *et al.* 2020; Việt 2021)
F21	non-academic aspects	Support services, financial aid, security etc. are considered non-academic aspects.	(Owlia and Aspinwall 1996; Kristensen *et al.* 2000; Abdullah 2006b; Muhammad *et al.* 2018; Ali *et al.* 2020; Việt 2021)
F22	dependability	Students rely on IT technical staff to assist with technical queries.	(Sultan and Wong 2010)
F23	effectiveness	Effective use of modern online tools and services.	(Sultan and Wong 2010)
F24	capability	Technical staff have the knowledge, skills and experience to assist promptly with student queries.	(Sultan and Wong 2010)
F25	efficiency	Promptness of delivery.	(Sultan and Wong 2010; Barkhuizen, Mogwere and Schutte 2014; Annamdevula and Bellamkonda 2016)
F26	assurance	Courtesy of technical staff; ability to encourage confidence and trust.	(Entwistle and Tait 1990; Sultan and Wong 2010)
F27	unusual situation management	The university's ability to address any dissatisfaction among learners, and any precautions against natural disasters.	(Sultan and Wong 2010)
F28	semester	Usually, six months.	(Sultan and Wong 2010)
F29	syllabus	Course content.	(Sultan and Wong 2010; Barkhuizen, Mogwere and Schutte 2014; Annamdevula and Bellamkonda 2016)
F30	teaching methodology	Method used to conduct lecturers e.g., using blackboard.	(Entwistle and Tait 1990; Carney 1994; Mai 2005; Senthilkumar and Arulraj 2010; Annamdevula and Bellamkonda 2016)
F31	disciplinary action	Reprimand in response to rule violation or misconduct.	(Senthilkumar and Arulraj 2010)
F32	environmental change in study factor	Universities involvement in reducing own carbon footprint.	(Senthilkumar and Arulraj 2010)
F33	mediating self-actualization placement	Fulfilment of one's talents and potentials.	(Senthilkumar and Arulraj 2010)
F34	NSE as a service quality measure	NSE dimensions of service quality include but not limited to content and structure of study, acquired general skills, acquired scientific skills, testing and assessment, program schedules etc.	(Schijns 2021)
F35	customer focus and need based	Customer is driven by a specific need.	(Sangeeta, Banwet and Karunes 2010)

F36	channels of communication	Examples: university website, WhatsApp communication, Facebook, twitter, alerts, reminders.	(Sangeeta, Banwet and Karunes 2010; Muthamia 2016)
F37	instructional competence	Important practices that lecturers must grasp for effective instruction to students to maximize knowledge and skills.	(Brooks 2005; Sangeeta, Banwet and Karunes 2010; Barkhuizen, Mogwere and Schutte 2014; Muthamia 2016)
F38	specific policies and procedures	Guidelines for the development. implementation, monitoring and evaluation of HEIs.	(Sangeeta, Banwet and Karunes 2010)
F39	evaluation and control system	Implemented through preparation of emergency policies and a crisis management team.	(Sangeeta, Banwet and Karunes 2010)
F40	curriculum design	Relevance of materials to students. Enthusiasm and methodology used by lecturers.	(Entwistle and Tait 1990; Abdullah 2006b; Banahene, Kraa and Kasu 2018)
F41	effective leadership	Efficient guidance.	(Sangeeta, Banwet and Karunes 2010)
F42	periodic review	Assessing regularly.	(Sangeeta, Banwet and Karunes 2010)
F43	resource allocation	Equipment provision.	(Sangeeta, Banwet and Karunes 2010)
F44	operational planning	Department goals, capabilities, and budgets.	(Sangeeta, Banwet and Karunes 2010)
F45	competence	Theoretical knowledge, practical knowledge, up to date, teaching expertise, communication.	(Sangeeta, Banwet and Karunes 2004; Mai 2005)
F46	attitude	Understanding the needs of students.	(Carney 1994; Owlia and Aspinwall 1996; Sangeeta, Banwet and Karunes 2004; Brooks 2005; Mai 2005)
F47	content	Documents given to students are easily obtainable and are accurate. Adherence to course objectives.	(Carney 1994; Owlia and Aspinwall 1996; Sangeeta, Banwet and Karunes 2004; Brooks 2005; Mai 2005)
F48	delivery	Easy access to IT technical support staff.	(Carney 1994; Owlia and Aspinwall 1996; Sangeeta, Banwet and Karunes 2004; Brooks 2005; Mai 2005)
F49	academic services	Includes admissions, financial aid, disability services etc.	(Brooks 2005; Mai 2005; Tsinidou, Gerogiannis and Fitsilis 2010; Raju and Bhaskar 2017)
F50	leisure	Relaxation.	(Raju and Bhaskar 2017)
F51	industry links	HEIs in contact with outside companies	(Raju and Bhaskar 2017)
F52	cost	Cost of facilities.	(Schwantz 1996; Raju and Bhaskar 2017)
F53	facilities	Tangibles, ease of access, support services, recreational facilities, library services, staff availability	(Schwantz 1996; Athiyaman 1997; Price *et al.* 2003; Annamdevula and Bellamkonda 2016; Azam 2018; Amponsah and Agyekum 2021)
F54	flexibility	Ability to assist out of normal hours.	(Schwantz 1996; Asaduzzaman, Moyazzem and Mahabubur 2013; Prasad and Madhavi 2014)
F55	availability	Reachable.	(Schwantz 1996; Athiyaman 1997; Barkhuizen, Mogwere and Schutte 2014; Prasad and Madhavi 2014; Alsabawy, Cater-Steel and Soar 2016; Muthamia 2016)
F56	personnel quality	Ability and skills of staff.	(Parasuraman *et al.* 1985; Schwantz 1996; Athiyaman 1997; Barkhuizen, Mogwere and Schutte 2014; Muthamia 2016)

F57	sufficiency of resources	Adequate facilities available for students to use, e.g., computer laboratories, libraries.	(Schwantz 1996; Pereda, Airey and Bennett 2007; Barkhuizen, Mogwere and Schutte 2014; Muthamia 2016)
F58	quality of faculty	Value of faculty.	(Schwantz 1996; Pereda, Airey and Bennett 2007; Barkhuizen, Mogwere and Schutte 2014; Amponsah and Agyekum 2021)
F59	access	Right to use.	(Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1991; Carney 1994; Owlia and Aspinwall 1996; Abdullah 2006c, 2006a; Tsinidou, Gerogiannis and Fitsilis 2010; Muhammad *et al.* 2018; Việt 2021)
F60	courtesy	Staff are courteous with students.	(Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1991; Carney 1994)
F61	communication	Between lecturer and student.	(Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1991; Carney 1994)
F62	credibility	Trustworthiness.	(Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1991; Carney 1994)
F63	security	Campus facilities are safe.	(Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1991; Carney 1994)
F64	understanding	Both student and lecturer appreciate each other.	(Parasuraman *et al.* 1985; Parasuraman, Zeithaml and Berry 1991; Carney 1994)
F65	standards of organizations	Each organization has its own policies and guidelines.	(Parasuraman *et al.* 1985)
F66	assessment	Evaluation methods.	(Parasuraman *et al.* 1985)
F67	feedback	Opinions from staff and students.	(Parasuraman *et al.* 1985)
F68	human resources quality	Capability and promptness of staff.	(Kristensen *et al.* 2000)
F69	privacy	Any information given by student (e.g., passwords) to technical staff is kept confidential.	(Alsabawy, Cater-Steel and Soar 2016)
F70	contact	Communication method.	(Alsabawy, Cater-Steel and Soar 2016)
F71	administrative services	Student support services.	(Carney 1994; Tsinidou, Gerogiannis and Fitsilis 2010; Annamdevula and Bellamkonda 2016; Azam 2018)
F72	campus infrastructure	Setup of HEI.	(Hampton 1993; Carney 1994; Annamdevula and Bellamkonda 2016)
F73	leadership	Authority.	(Hampton 1993; Ho and Wearn 1996)
F74	perishability	A service that cannot be made in advanced and stored.	(Goetsch and Davis 2000)
F75	intangibility	A service has no physical substance.	(Goetsch and Davis 2000)
F76	variability	A service may vary in quality from one provider to the next.	(Goetsch and Davis 2000)
F77	lack of ownership	Shortage or absence of something required.	(Goetsch and Davis 2000)
F78	inseparability	Makes customer-provider collaboration compulsory.	(Goetsch and Davis 2000)
F79	infrastructure	Setup of an organization.	(Gibson, Ivancevich and Konopaske 2006)
F80	teamwork	Colleagues working together.	(Gibson, Ivancevich and Konopaske 2006)
F81	institutions management	Process of planning and organizing resources to run a successful organization.	(Navarro-Marzo, Pedraja-Iglesias and Rivera-Torres 2005)

b. *Data Standardization:* Data normalization is referred to as scaling in PCA. The dataset is changed in this case by utilizing the equation 3.1. This means that the attribute's mean is zero and the corresponding distribution has a standard deviation of one. The dataset was formatted as follows:

$$Xij = (Xij - Xm) / \sigma \qquad (3.1)$$

where i = 1, 2, 3, . . ., 100 (extracted studies) and j = 1, 2, 3, ..., 81 (extracted factors), Xij represents the original value of the i^{th} research rating of the j^{th} factor, Xm is the mean, and σ represents the standard deviation of the series formed by values of the i^{th} research for all 81 factors. The R-Studio function scale () was used to normalize the data to ensure that each factor contributes equally to the computation of principal components (Sharma 2008; Jolliffe and Cadima 2016; Mattah, Kwarteng and Mensah 2018; Zaleski and Michalski 2021). As input, the numeric matrix is entered, and then the scaling on the columns is performed (STHDA 2019).

c. *Principal Component Analysis:* Principal component analysis (PCA) is a multivariate statistical technique that summarizes data by breaking it down into principal components (PCs), which are smaller elements that can be used to assess the construct more precisely without sacrificing any of the data's information (Hanci and Cebeci 2019). PCA was applied to R-Studio using built-in R stats package tools.

To clarify further, the equation provided is related to the dataset in the context of data standardization or normalization. In this case, the dataset contains numerical values representing the ratings of factors extracted from research studies. The equation is used to transform these values so that it can have a mean of zero and a standard deviation of one. This standardization process is important in principal component analysis (PCA), where it helps ensure that each factor contributes equally to the computation of principal components. Xm represents the mean of the values for a specific factor across all research studies, and σ represents the standard deviation of these values. By applying this equation to each value in the dataset, the data is effectively standardized so that it is on a common scale, making it easier to compare and analyze the factors across different studies.

As shown in Table 3.2, 25 factors have been recognized as significant success factors in determining students' satisfaction with information technology technical support services provided at higher education institutions.

The SERVQUAL dimensions (responsiveness, assurance, empathy, reliability, and tangibility) are the first five highest-ranked factors. This study aims to evaluate students' level of satisfaction with information technology technical support services in higher education institutes, therefore these five factors were employed to design the questionnaire.

Table 3.2 Rank Attributes with 5-Factor Loadings

RANKED	ATTRIBUTES	CONTRIBUTION
0.8813	1	-0.224F4-0.22F5-0.203F2+0.193F30+0.192F57...
0.7779	2	-0.292F41-0.292F42-0.292F39-0.292F38-0.292F43...
0.6936	3	-0.23F24-0.23F26-0.228F23-0.228F27-0.228F28...
0.6175	4	0.371F16+0.371F15+0.371F18+0.371F19+0.371F14...
0.5488	5	0.247F22+0.247F28+0.247F27+0.247F23+0.206F67...
0.4853	6	-0.402F77-0.402F76-0.402F75-0.402F74-0.402F78...
0.4329	7	0.372F20+0.36 F21+0.33 F9+0.217F6-0.207F5...
0.3905	8	0.389F31+0.389F33+0.389F32-0.246F46-0.246F48...
0.3515	9	0.304F33+0.304F31+0.304F32-0.259F52-0.248F51...
0.3145	10	-0.276F69-0.276F70-0.267F55-0.257F11-0.231F25...
0.2809	11	0.48 F50+0.48 F51+0.28 F49+0.253F52-0.208F72...
0.2507	12	-0.482F80-0.482F79-0.347F54+0.25 F11+0.23 F12...
0.2215	13	-0.446F69-0.446F70+0.286F11+0.253F80+0.253F79...
0.1933	14	0.271F10-0.258F20-0.255F21+0.241F67+0.241F65...
0.1695	15	0.338F12+0.324F7+0.323F6-0.243F10+0.219F13...
0.1506	16	0.626F73+0.322F7-0.288F13+0.288F58-0.253F10...
0.1333	17	-0.631F68-0.438F6+0.225F9+0.178F59+0.154F40...
0.1184	18	-0.339F34+0.318F72+0.3 F71-0.289F10+0.272F49...
0.105	19	0.584F34+0.514F81-0.364F10-0.185F12-0.185F29...
0.092	20	0.796F81-0.493F34+0.126F10-0.111F4-0.105F5...
0.0804	21	-0.376F8+0.271F13+0.256F58+0.217F56-0.21F6...
0.0694	22	-0.402F53+0.327F68+0.318F58-0.303F56+0.262F57...
0.0597	23	0.409F34+0.326F58+0.31 F29+0.281F57+0.266F3...
0.0511	24	0.504F7-0.368F53+0.312F49-0.292F58+0.24 F29...
0.0433	25	-0.536F45+0.288F8+0.278F10+0.273F49-0.261F40...

The top five factors (responsiveness, assurance, empathy, reliability, and tangibility) of PCA aligns with the SERVQUAL dimensions, suggesting a robust relationship between the empirical data and SERVQUAL theoretical construct.

3.2 SERVQUAL

The SERVQUAL model is a widely recognized framework for measuring customer satisfaction in higher education institutions (Fuchs and Fangpong 2021; Sibai, Bay and Rosa 2021; Aboubakr and Bayoumy 2022; Hoque *et al.* 2023). Applying the SERVQUAL model can provide a comprehensive benchmark for evaluating student satisfaction levels with IT technical support services. The five

dimensions of the SERVQUAL model, reliability, assurance, tangibles, empathy, and responsiveness were gathered from the principal component analysis.

Studies by Bennington and Cummane (1998), Leonnard (2018) and Stribbell and Duangekanong (2022) have shown that the SERVQUAL framework is an effective tool for evaluating service quality in higher education institutions.

The study examines the relationship between the five aspects of quality of service, demographic factors, and student satisfaction with IT technical support services. Finally, the SERVQUAL dimensions employed in the questionnaire design are explained.

3.2.1 SERVQUAL Model for Questionnaire

In this study, *Student Satisfaction with IT Technical Support Services* is the dependent variable and *Reliability, Tangibility, Responsiveness, Assurance, Empathy, and Demographic factors (age, gender, study type, department, and study level)* are the independent variables. The questionnaire was constructed employing the framework represented in Figure 3.2.

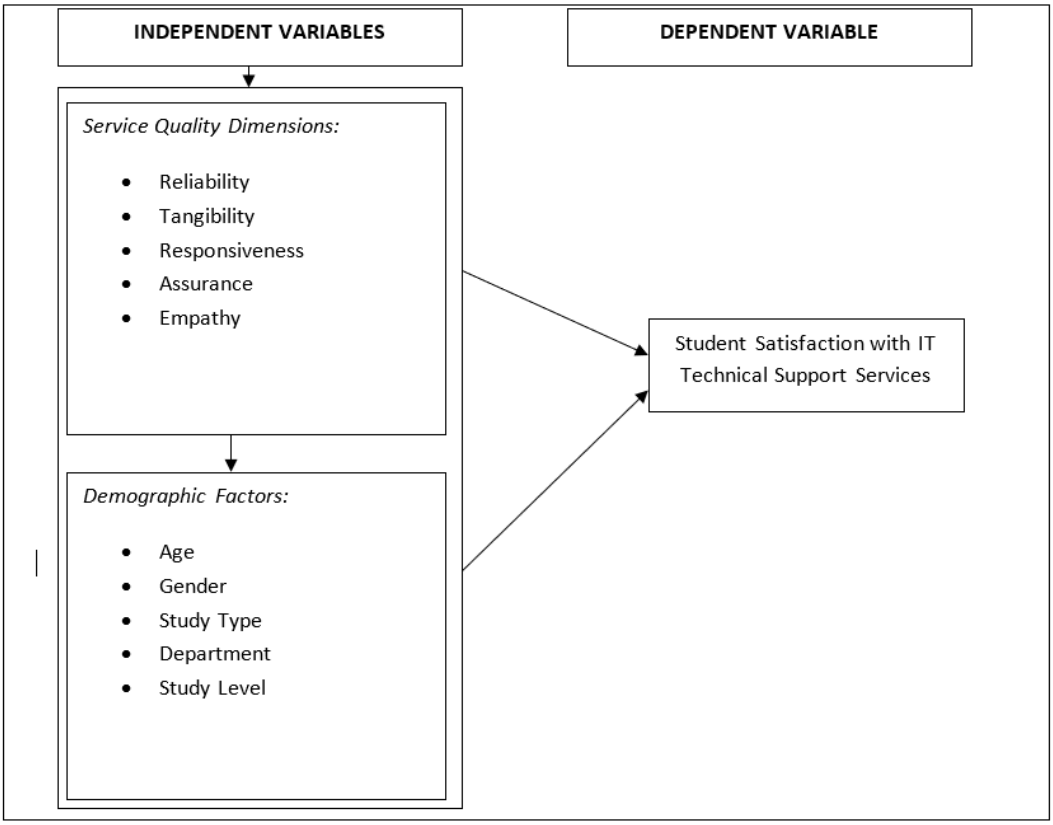

Figure 3.2. Framework with 11 Main Aspects of Student IT Technical Support Service Evaluation

3.2.2 Student Satisfaction

Satisfaction refers to the emotional assessment of the different outcomes that can also apply to viewpoints seen as lovely or upsetting (Alzahrani and Seth 2021).

According to Park and Kim (2013), "Student Satisfaction is a form that someone acquires performance experience (or results) that meets his expectations, which includes; 1) service wait time, 2) service speed and accuracy, 3) accuracy in keeping appointments, 4) hospitality and courtesy of leaders, lecturers, and staff in behaving and speaking, 5) knowledge of lecturers and employees in giving service, 6) procedures in service and adjustment of services, 7) ease of contact of leaders, lecturers, and staff, 8) comfortable, clean service place for students, 9) creating smooth service, 10) service hospitality influencing student satisfaction." A questionnaire with items measured on a five-point Likert scale was employed.

3.2.3 Demographic Factors

In addition to SERVQUAL dimensions used, this study also tries to put together demographic factors that will be used to measure the IT technical support service quality level of student satisfaction. These factors include age, gender, study type, department, and study level (see Figure 3.2).

3.2.4 SERVQUAL Dimensions

SERVQUAL is a service quality measurement scale that was proposed by (Parasuraman, Zeithaml and Berry 1988). It identifies the five dimensions that customers employ to evaluate service quality which includes reliability services, tangibility services, responsiveness services, assurance services and empathy services.

3.2.4.1 Reliability Services

The student is assured that support staff to help resolve their queries promptly. Student has confidence in support staff accessing their laptops to resolve a problem. Appointment times made by students are kept by support staff.

3.2.4.2 Tangibility Services

The use of WhatsApp as a communication medium to provide support services to students.

3.2.4.3 Responsiveness Services

IT technical support staff’s willingness to assist students and provide them with prompt service. This dimension looks at promptness and thoughtfulness when dealing with student questions, requests, problems, and complaints. It also looks at the length of time that students have to wait to get the attention of IT technical support staff.

3.2.4.4 Assurance Services

It includes IT technical support staff being courteous to students as well as staff knowing to answer students’ queries.

3.2.4.5 Empathy Services

It includes IT technical support staff giving students personal attention and understanding the students' specific needs. Empathy reflects how much the technical staff cares and feels for the needs of the students. These aspects make it possible to determine the level of student IT technical support service quality and evaluate it.

3.2.5 Research Paradigm

The research paradigm that has been selected for this study is post-positivism as it allows for human actions and behaviour to be examined (Panhwar, Ansari and Shah 2017). It is a research paradigm that emphasizes quantitative approaches (Creswell and Creswell 2018). Post-positivism offers a perspective that broadens the scientific method to include constant analysis (Ryan 2006). This can provide valuable insights into management and decision-making processes. The clear and quantifiable data generated through positivist approaches can inform administrators and policymakers about the specific areas of IT technical support services that require improvement to enhance student satisfaction. Therefore, the post-positivist paradigm to analyse the responses of the student's satisfaction levels with the IT technical support services provided at higher educational institutions is well suited to this study.

3.2.6 Research Methodology

The methodology of this study is a hybrid of quantitative mathematical modelling that is based on decision theory and questionnaire to evaluate the satisfaction level of students with the IT technical support services offered. This study uses an online survey questionnaire to collect data with questions that are precise, well-structured, straightforward, and measurable with a 5-point Likert scale rating so that the information gathered from respondents may be validated and reliably assessed scientifically. The WhatsApp messaging application was chosen to disseminate questionnaires to students. The questionnaire's structure was created using Google Forms. The students were provided with a uniform resource locator (URL) so they could access and complete the survey. This messaging application was used by many students during the COVID-19 pandemic so the researcher thought it would be best to disseminate the questionnaires using this method. The quantitative method uses FTOPSIS decision method to rank the sub-criteria based on their relative closeness to the ideal solution (Abdul and Wenqi 2022). The sub-criteria that is closest to the ideal solution is the most preferred sub-criteria.

3.2.7 Research Design

Research design is the plan or the blueprint that outlines the framework of a research study (Creswell and Creswell 2018). It is an essential aspect as it helps researchers to systematize the study, identify

potential research problems that could arise during the research process, and gather and interpret data in a logical and structured way. A research design should be able to answer the research question or hypothesis and to provide relevant and reliable results (Creswell and Creswell 2018). Therefore, descriptive research was used to elucidate the study context of SERVQUAL accurately and systematically. In this regard, descriptive research suits this study as the research anticipated and evaluated the level of satisfaction in higher education students with IT technical support services being provided (Creswell and Creswell 2018).

3.2.8 Research Setting and Target Population

This study is conducted at a South African University of Technology. The target population of this study is students from the Durban University of Technology who have interacted with the technical support staff in terms of the IT technical support services. It includes students namely, diploma and degree such as first and final years. Students from various departments irrespective of being part-time or full-time at the university was selected to participate in this study.

3.2.9 Sampling Strategy

To ensure that specific individuals could provide the essential information for this analysis, the researcher used a purposive sampling approach. The students were selected based on their experiences with the IT technical support services offered by the institution. Purposive sampling entails hand-picking participants from the available population because they are the only ones who can provide the required data because they meet certain requirements set by the researcher, indicating that they are representative or typical of the population (Gliner, Morgan and Leech 2017). The students were selected based on their experiences with the IT technical support services offered by the institution using purposive sampling.

3.2.10 Sample Size

To conduct the study with an entire population will be impossible; therefore, the researcher has decided to design the sample in such a way that the sample that is taken will represent the entire population. As Roscoe (1975) cites in Sekaran (2000) a sample size between 30 and 500 are appropriate for most research. Questionnaires were distributed to 250 students; however, 196 responses were received. This represents a response rate of 78.4%. These responses were from a variety of departments at the Durban University of Technology and these 196 students were selected for this research project.

3.2.11 Reliability

Reliability refers to the degree to which a measure or research instrument produces consistent and stable results over time and across different samples. In other words, if a measure is reliable, it should

produce similar results when used repeatedly to measure the same concept. The Cronbach Alpha test was used in this study to assess the internal consistency and reliability of the questionnaire's variables.

3.2.12 Validity

Validity refers to the extent to which a measure or research instrument measures what it is intended to measure. In other words, if a measure is valid, it accurately reflects the concept or construct that the researcher is trying to measure. Prior to the pilot study, the survey questionnaire was assessed for validity by two technical support experts. A synopsis of the study, including the aim and objectives, as well as an explanation of each criterion (Figure 3.2) on which the questionnaire was based, was also presented to the technical support staff. The feedback from this approach necessitated one change to the questionnaire as mentioned (Section 3.2.15).

3.2.13 Ethical Considerations

Ethical approval was sought from the Institutional Research Ethics Committee (IREC) prior to the commencement of data collection towards the study. Once approval was obtained, the researcher sent the approval letter and uniform resource locator (URL) to each student via WhatsApp so they could access and complete the online questionnaire. Anonymity and confidentiality was assured to the participants, and that the data collected will be kept confidential and used for research purposes only. The first section of the questionnaire looked at demographic information such age, gender, study type, level, and department. Each question was required to be answered for the survey to be submitted successfully. Since there was no face-to-face interaction because it was a questionnaire via the internet, anonymity was also preserved, improving data security and accuracy.

3.2.14 Recruitment of Participants

An informational letter was sent to 250 students on the researcher's contact list via WhatsApp. Students were able to recognize the researcher because they had contacted the IT technical support WhatsApp number both during the COVID-19 pandemic and presently.

3.2.15 Pilot Study

This pilot project's main objectives were to pretest the questionnaire to ensure that the respondents correctly interpreted it and to evaluate the caliber of the data collected. In order to determine whether the sample questionnaire was logical and in line with the study's goals, a small sample of respondents participated in the pilot project. Ten students from the target population were randomly chosen via the WhatsApp contact list to participate in the pilot survey before the final questionnaire is to be distributed. The researcher decided to send out questionnaires to participants via WhatsApp. The researcher decided it would be preferable to distribute the questionnaires via this service method

because it was utilized by several students during the COVID epidemic. Through the use of an online survey, data were collected. The questionnaire's structure was created using Google Forms. The students were provided with a uniform resource locator (URL) so they could access and complete the survey. The time it took to administer the pilot questionnaires ranged from 20 to 30 minutes. Participants were given the assurance that the information gathered would be kept private and used only for research. The survey's piloting gave the researcher the opportunity to rigorously assess the survey's validity. As a result, the questionnaire underwent the following change:

Question 2.11.2 was re-worded to be more precise and understandable by respondents. Participants were to give their initial opinions in response to the following statement/question: "*How do you rate the IT technical support services provided to you during the online lecturing/quiz/exam during COVID-19?*" After reviewing the participant responses, the researcher concluded that this assertion was too general to enable participants to respond to the query of whether they were happy or dissatisfied with the IT technical support services provided during the online lectures, quizzes, and exam during COVID-19. Therefore, this question/statement was modified, with the final statement reading as: "*I feel satisfied with the IT technical support services provided during the online lecturing/quiz/exam during COVID-19*". This revised statement is intended to better the participants' comprehension of the topic by enabling the researcher to assess their level of satisfaction with particular IT technical support services. This process was helpful in determining the reliability and validity of the survey items.

3.2.16 Data Collection

Data was collected using a structured questionnaire that was designed using the SERVQUAL framework. A total of 250 students received the questionnaire via WhatsApp messaging. No questionnaires had any missing information because the researcher had specified that each question be answered before moving on to the next one. Participants were given the assurance that the information gathered would be kept private and used only for research. A total of 250 questionnaires were sent out to the participants; however, only 196 responded to the questionnaire. This represents a response rate of 78.4%. The questionnaire consisted of two sections. The first section of the questionnaire included the demographic questions such as age, gender, study type, study level and department. The second section included the SERVQUAL questions that measures the students' satisfaction levels with the IT technical support services offered the institution. There were 44 multiple-choice questions in total, three to five for each of the eleven variables. These factors are illustrated in Table 3.3. The questions for the factors (service response, service assurance, trustworthiness and loyalty, commitment, competence, reputation, technical support staff, communication material, method of communication, location and satisfaction level) were modified in accordance with this study (Refer to Table 3.3). The questionnaire included a five-point Likert scale (1–5) to assess participant satisfaction, ranging from "strongly disagree" to "strongly agree".

Table 3.3 IT Technical Support Service Factors for the Questionnaire

No.	Criteria	Sub-Criteria	Description
1	Responsiveness(C1)	Service Response1	Technical support staff is determined to please students.
2		Service Response2	Students are always welcomed and well received.
3		Service Response3	Technical support staff respond faster to students WhatsApp messages, call or emails.
4		Service Response4	Technical support staff promptly respond to student queries.
5		Service Response5	Technical support staff sends computing service specials via email to regular students.
6		Commitment1	Staff always understand specific needs of students.
7		Commitment2	Staff always available to assist students.
8		Commitment3	Technical support staff see students as number one priority.
9		Commitment4	Technical support staff maintain good interaction with students.
10		Commitment5	Technical support staff give students individual attention.
11	Assurance(C2)	Service Assurance1	Technical support keep to their promises.
12		Service Assurance2	Staff are courteous with students.
13		Service Assurance3	Information is always kept confidential.
14		Service Assurance4	Technical support staff are always willing to help students.
15		Service Assurance5	Technical support staff are polite with students.
16	Empathy(C3)	Trustworthiness and Loyalty1	Students impose trust on Technical support staff.
17		Trustworthiness and Loyalty2	Staff show sincere interest in solving queries.
18		Trustworthiness and Loyalty3	Technical support staff are friendly towards student's sincerity.
19		Trustworthiness and Loyalty4	Technical support staff are aware of students frequently asked questions.
20	Reliability(C5)	Competence1	Employees take responsibility for errors occurred and quickly reassures student
21		Competence2	Employee act quickly on students' dissatisfactions

22		Competence3	Employee is aware of what to do when students are unhappy
23		Competence4	Staff go to great lengths in making sure the student is a “happy customer” at the end of the day.
24		Competence5	Staff have appropriate knowledge and skills.
25		Reputation1	Technical support staff are consistent in terms of service delivery.
26		Reputation2	Personal service is given to students.
27		Reputation3	Staff have students’ best interest at heart.
28	Tangibility(C4)	Technical Support Staff1	Timeliness of solution provided.
29		Technical Support Staff2	Knowledge and skills of personnel.
30		Technical Support Staff3	Effectiveness of solution provided.
31		Technical Support Staff4	Effective use of modern online tools and services.
32		Communication Material1	Information provided by support staff is appropriate.
33		Communication Material2	Documents provided are easily accessible and accurate.
34		Communication Material3	Steps provided in the documents are easy to follow.
35		Method of Communication1	Tech staff are easily accessible by WhatsApp service.
36		Method of Communication2	The WhatsApp service is easy to use.
37		Method of Communication3	WhatsApp service is reliable.
38		Location1	Remote technical support provided – ideal location especially during the pandemic.
39		Location2	Remote technical support is available 24/7.
40		Location3	Remote technical support provided is very convenient.
41	Satisfaction Level (C6)	Satisfaction Level1	I feel satisfied with the technical support service when I face technical problems.
42		Satisfaction Level2	I feel satisfied with the IT technical support services provided during the online lecturing/quiz/exam during COVID-19.
43		Satisfaction Level3	Are you satisfied with the IT support services provided in case of technical issues that happened during the exam or lecture?
44		Satisfaction Level4	Overall, I am satisfied with the remote technical support service that is being provided.

3.3 Fuzzy TOPSIS

The widely known acronym FTOPSIS stands for Fuzzy Technique for Order Preference by Similarity to Ideal Solution. The FTOPSIS technique uses fuzzy evaluations of TOPSIS's criteria and options (Hwang and Yoon 1981). Decision theory helps understand how people make decisions, aiding in evaluating satisfaction levels by identifying important criteria for students. Fuzzy TOPSIS ranks sub-criteria based on performance against criteria, suited for subjective evaluations. It quantitatively evaluates and ranks technical support services based on criteria like responsiveness and overall satisfaction, aiding in analyzing complex data and identifying effective services. This approach allows for a structured evaluation of students' satisfaction levels, identifying areas for improvement and enhancing the quality of technical support services, hence decision theory and fuzzy TOPSIS were employed in this study. The TOPSIS method selects the option that is most likely to result in a positive ideal solution and the least likely to result in a negative ideal solution. The best performance values for each criterion make up a positive ideal solution, whilst the poorest performance values make up a negative ideal solution. The decision-making dataset was loaded into MATLAB version R2023a for data analysis. Then, the code of the Fuzzy TOPSIS approach was implemented in MATLAB using a computer with Windows 10 64-bit operating system installed. 196 students evaluated the ratings of sub-criteria with regard to multiple selection criteria, and IT technical support professionals in the field determined the various weights of all criteria using a survey questionnaire and linguistic values that can be defined by triangular Fuzzy number (Awasthi *et al.* 2011).

3.3.1 Biographical Analysis

In order to aid in the analysis of the survey response, the first section of the survey questionnaire requested information on the demographic profile of respondents, including their age, gender, study type, study level, and department. Tables and graphs are used to convey descriptive analysis. It involves an in-depth review of each part of the primary study questionnaire.

3.3.2 Inferential Analysis

Using the FUZZY TOPSIS decision method for inferential analysis allows for a comprehensive evaluation of satisfaction levels among higher education students with technical support services. It considers multiple criteria, incorporates uncertainty through fuzzy sets, and provides a structured approach to ranking sub-criteria.

3.3.3 Decision Theory

Decision theory is a systematic approach to making choices when faced with uncertainty or multiple criteria, and it provides a structured framework for analysing complex decision problems (Petrov *et al.* 2020; Awang, Samy and Hassan 2022). It plays a pivotal role in evaluating the level of satisfaction

in higher education students with technical support services provided using the FUZZY TOPSIS decision method. In the context of evaluating student satisfaction with technical support services, decision theory is adapted from Westmaas, BA. and MSc. (2022) and applied as follows:

a. Identification of Objectives and Criteria: Decision theory begins by identifying the objectives or goals of the evaluation process. In this case, the primary objective is to assess student satisfaction with technical support services. Various criteria are identified, such as service response, competence, method of communication, communication material, service assurance, and any other relevant factors that contribute to student satisfaction.

b. Data Collection and Measurement: Data on these criteria are collected through questionnaire surveys with students. These data help quantify the different aspects of technical support services and student satisfaction. Decision theory ensures that data collection is systematic and unbiased.

c. Fuzzy Logic and Uncertainty Handling: FUZZY TOPSIS is a multi-criteria decision-making method that deals with imprecise or fuzzy data. In the context of evaluating student satisfaction, student responses are often subjective and may not be expressed in precise numerical terms. Decision theory, in conjunction with FUZZY TOPSIS, accommodates this uncertainty by allowing for fuzzy logic and linguistic variables.

d. Normalization and Weighting: Decision theory involves normalizing the criteria and assigning weights to them based on the relative importance. For example, if service response is deemed more critical than service assurance, decision theory helps assign appropriate weights to reflect this preference.

e. Preference Modelling: FUZZY TOPSIS is particularly useful in capturing the preferences of decision-makers when criteria have different degrees of importance or satisfaction. It creates a preference model that quantifies how well each sub-criteria (in this case, different aspects of technical support services) satisfies the objectives and criteria.

f. Similarity to Ideal Solution: The FUZZY TOPSIS method calculates the similarity of each sub-criteria to the ideal solution, considering both the positive and negative ideal solutions. It measures how well each aspect of technical support services aligns with the ideal level of student satisfaction.

g. Ranking and Selection: Based on the similarity scores, the decision theory and FUZZY TOPSIS combination generates a ranking of the aspects of technical support services. This ranking helps institutions identify areas that require improvement and prioritize resource allocation accordingly.

h. Decision-Making and Actionable Insights: Ultimately, the application of decision theory and FUZZY TOPSIS provides actionable insights for higher education institutions. It aids in making informed decisions regarding improvements to technical support services to enhance student satisfaction.

In summary, decision theory, when coupled with the FUZZY TOPSIS decision method, offers a systematic and flexible approach for evaluating student satisfaction with technical support services in higher education. It ensures that the evaluation process is structured, data-driven, and capable of handling the inherent uncertainty and subjectivity associated with student feedback.

3.3.4 Fuzzy TOPSIS Model

Fuzzy TOPSIS is used in this research to evaluate student satisfaction levels with IT technical support services based on multiple criteria, such as technical knowledge of the support staff, response time, and availability. Additionally, by applying the Fuzzy TOPSIS model, the research aims to provide a more accurate evaluation of student satisfaction levels based on multiple criteria. This study aims to evaluate student satisfaction levels using the SERVQUAL model and the Fuzzy TOPSIS model to identify factors that contribute to student satisfaction with IT technical support services and provide insights into areas that need improvement.

3.3.4.1 Fuzzy TOPSIS Method

Many arithmetical evaluation techniques can be applied to multi-objective decision optimization including principal component analysis, analytic hierarchy process, weighted FTOPSIS method and fuzzy math comprehensive judgment etc. However, the FTOPSIS method allocation of data, content and samples of the indexes did not rigorously limit the number criteria. Furthermore, its simplicity and ease of execution make it renowned among many decision-making methods. The practical model is based on thoughts rather than data, mathematical calculation is simple and other aspects to make it an all-complete evaluation method used commonly to compare student IT technical support service quality suitable for university evaluation.

The FTOPSIS method is used to assess samples comprehensively. It is used to measure the distance between the index value vector of each sample and the positive ideal solution along with the negative ideal solution. The values are used to rank the distances. The Fuzzy Positive Ideal Solution (FPIS) is

the ideal optimal solution in which each index achieves the optimal value in the overall assessment. A fuzzy negative Ideal Solution (FNIS) is the worst possible solution to another hypothesis (Raja and Rajan 2022). The approach computes the distance between the index evaluation vectors and the best solution, as well as the distance between the index evaluation vectors and the worst solution (Wang, Thu Nguyen and Phan 2022). The sample is considered ideal if its index is closest to the optimal solution while being far from the worst solution; otherwise, it is considered the worst solution. (Awasthi *et al.* 2011).

3.3.4.2 Principle of Fuzzy TOPSIS

(Kaufmann and Gupta 1991; Pedrycz 1994; Klir and Yuan 1995) define fuzzy set theory as:

Definition 1. A fuzzy set ā in a universe of discourse X is characterized by a membership function μā(x) that maps each element x in X to a real number in the interval [0, 1]. The function value μā(x) is termed the grade of membership of x in ā (Kaufmann and Gupta 1991). The nearer the value of μā(x) to unity, the higher the grade of membership of x in ã.

Definition 2: A triangular fuzzy number is represented as a triplet ā = (a, b, c) Han and Trimi (2018), as illustrated in Figure 3.3.

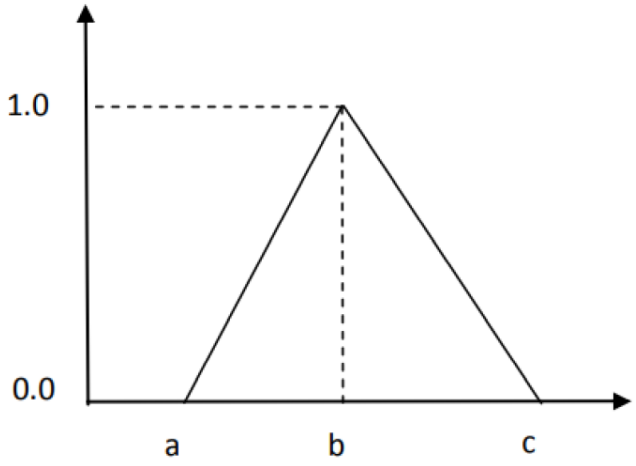

Figure 3.3. Membership Function F(x) of a Triangular Fuzzy number Ã.

The membership function μā(x) of triangular fuzzy number ā is shown in equation 3.2.

$$F(x) = \begin{cases} \dfrac{x-a}{b-a}, & a \le x \le b \\ \dfrac{c-x}{c-b}, & b \le x \le c \\ 0, & otherwise \end{cases} \quad (3.2)$$

Linguistic Variables and Fuzzy Set Theory

In fuzzy set theory, conversion scales are applied to transform the linguistic terms into fuzzy numbers (Awasthi *et al.* 2011). In this study, a scale of 1–9 is used to rate the criteria and the sub-criteria. Table 3.4 presents the linguistic variables and fuzzy ratings used for the sub-criteria and Table 3.5 presents the linguistic variables and fuzzy ratings used for the criteria.

Table 3.4 Linguistic Terms for Sub-Criteria Ratings
Source: Researcher's Own Ratings

Linguistic Term	Membership Function
Strongly Disagree (SD)	(1,1,3)
Disagree (D)	(1,3,5)
Slightly Agree (SA)	(3,5,7)
Agree (A)	(5,7,9)
Strongly Agree (STA)	(7,9,9)

Table 3.5 Linguistic Terms for Criteria Ratings
Source: Extracted from Awasthi *et al.* (2011)

Linguistic Term	Membership Function
Very poor (VP)	(1,1,3)
Poor (P)	(1,3,5)
Fair (F)	(3,5,7)
Good (G)	(5,7,9)
Very Good (VG)	(7,9,9)

The Fuzzy TOPSIS method as outlined by (Awasthi *et al.* 2011):

Step 1: Assignment of ratings to the criteria and the alternatives. Let us assume there are J possible alternative called $A = \{A_1, A_2, A_j\}$ which are to be evaluated against m criteria, $C = \{C_1, C_2, C_m\}$. The criteria weights are denoted by w_i $(i = 1, 2, \ldots, m)$. The performance ratings of each decision maker D_k $(k = 1, 2, \ldots, K)$ for each alternative $A_j (j = 1, 2, \ldots, n)$ with respect to criteria $C_i (i = 1, 2, \ldots, m)$ are denoted by $\hat{R}_k = \tilde{x}_{ijk} (I = 1,2,\ldots m;\ j = 1,2,\ldots,n; k=1,2,\ldots,K)$ with

membership function $\mu_{\sim Rk}(x)$.

Step 2: Compute aggregate fuzzy ratings for the criteria and the alternatives. If the fuzzy ratings of all decision makers are described as triangular fuzzy number $\hat{R}_k = (a_k, b_k, c_k)$, $k = 1,2, \ldots, K$ then the aggregated fuzzy rating is given by $\hat{R}_k = (a, b, c), k = 1,2,\ldots,K$ where:

$$a = \min_k \{a_k\},\ b = \frac{1}{K}\sum_{k=1}^{k} b_k,\ c = \max_k \{c_k\} \quad (3.2)$$

If the fuzzy rating and importance weight of the kth decision maker are $\tilde{x}_{ijk} = (a_{ijk}, b_{ijk}, c_{ijk})$ and $\hat{w}_{ijk} = (w_{jk1}, w_{jk2}, w_{jk3})$, $I = 1,2,\ldots,m$, $j = 1,2,\ldots n$ respectively, then the aggregated fuzzy ratings ($\tilde{x}_{ij}$) of alternatives with respect to each criterion are given by $\tilde{x}_{ij}\ (a_{ij}, b_{ij}, c_{ij})$ where

$$a = \min_k \{a_{ijk}\},\ b_{ij} = \frac{1}{K}\sum_{k=1}^{k} b_{ijk},\ c_{ij} = \max_k \{c_{ijk}\} \quad (3.3)$$

The aggregated fuzzy weights () of each criterion are calculated as $\hat{w}_j = (w_{j1}, w_{j2}, w_{j3})$ where

$$\hat{w}_{j1} = \min_k\{w_{jk1}\},\ w_{j2},\ w_{j3} = \max_k\{c_{jk3}\} \quad (3.4)$$

Step 3: Compute the fuzzy decision matrix. The fuzzy decision matrix for the ($\widetilde{D}$) and the criteria ($\widetilde{W}$) is constructed as follows:

$$\widetilde{D} = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \ldots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \ldots & \tilde{x}_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \ldots & \tilde{x}_{mn} \end{bmatrix} \end{array}, \quad i = 1,2,\ldots,m; j = 1,2,\ldots,n \quad (3.5)$$

$$\widetilde{W} = (\hat{w}_1, \hat{w}_2, \hat{w}_a) \quad (3.6)$$

Step 3: Normalize the fuzzy decision matrix. The raw data are normalized using linear scale transformation to bring the various criteria scales into a comparable scale. The normalized fuzzy decision matrix $\tilde{R}$ is given by:

$$\hat{R} = [\tilde{r}_{ij}]_{mxn},\ I = 1,2,\ldots,\ m;\ j = 1,2,\ldots n \quad (3.7)$$

where:

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad \text{and} \quad c_j^* = \max_i c_{ij} \quad (\text{benefit criteria}) \quad (3.8)$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \quad \text{and} \quad a_j^- = \min_i a_{ij} \quad (\text{cost criteria}) \tag{3.9}$$

Step 4: Compute the weighted normalized matrix. The weighted normalized matrix $\tilde{V}$ for criteria is computed by multiplying the weights ($\hat{w}_j$) of evaluation criteria with the normalized fuzzy decision matrix $\tilde{r}_{ij}$.

$\tilde{V} = [\tilde{V}_{ij}]_{mxn}$, i = 1,2,…m;

j = 1,2,…,n where $\tilde{v}_{ij} = \tilde{r}_{ij}(.)\ \tilde{w}_j$ (3.10)

Step 5: Compute the fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS)

The FPIS and FNIS of the alternatives is computed as follows:

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \ldots, \tilde{v}_n^*) \quad \text{where } \tilde{v}_j^* = \max_i \{v_{ij3}\}, \quad i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n \tag{3.11}$$

$$A^- = (\tilde{v}_1, \tilde{v}_2, \ldots, \tilde{v}_n) \quad \text{where } \tilde{v}_j^- = \min_i \{v_{ij1}\}, \quad i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n \tag{3.12}$$

Step 6: Compute the distance of each alternative from FPIS and FNIS:

The distance (d_i^*, d_i^-) of each weighted alternative i = 1, 2, . . ., m from the FPIS and the FNIS is computed as follows:

$$d_i^* = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^*\right), \quad i = 1,2,\ldots,m \tag{3.13}$$

$$d_i^- = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), \quad i = 1,2,\ldots,m \tag{3.14}$$

Where $d_v(\tilde{a},\tilde{b})$ is the distance measurement between two fuzzy numbers $\tilde{a}$ and $\tilde{b}$ and $d_v(\tilde{a},\tilde{b})$ =

$$\sqrt{\tfrac{1}{3}[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]}$$

Step 7: Compute the closeness coefficient (CC_i) of each alternative. The closeness coefficient represents the distances to the fuzzy positive ideal solution (A*) and the fuzzy negative ideal solution (A-) simultaneously. The closeness coefficient of each alternative is calculated as:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*}, \quad i = 1, 2, \ldots, m \tag{3.15}$$

Step 8: Rank the alternatives

In step 9, the different alternatives are ranked according to the closeness coefficient (CC_i) in decreasing order. The best alternative is closest to the FPIS and farthest from the FNIS.

A simple example using Fuzzy TOPSIS is shown in Annexure A.

3.4 Summary

The study's target population, data collection methods, and tools were covered in this chapter along with the research methodology. It covered the data gathering and analysis process as well as the study's research strategy and methodology. This chapter additionally examined the metrics to be computed in the study and the research methods. The results of this investigation will be thoroughly analysed, and an explanation of the findings will be provided, in the next chapter.

CHAPTER FOUR: PRESENTATION OF RESULTS AND DISCUSSION

This chapter presents the findings of the statistical analysis performed on data obtained from student surveys conducted. The results of the reliability and significance tests conducted on the data are also presented here. The data is applied to the Fuzzy TOPSIS algorithm using MATLAB R2023a to rank the eleven sub-criteria considered in the study. Cross-tabulations for various factors that could influence student satisfaction are examined.

4.1 Survey Statistical Analysis

This section presents the sample used in the study, research instrument, reliability and validity statistics, biographical data analysis, the results of the survey, cross tabulations for factors that could influence satisfaction are examined, chi-square test is carried out to determine if there is a statistically significant relationship between the variables.

4.1.1 Sample

Students from a purposive sample of 250 were given the opportunity to participate in the survey. From the 250 questionnaires that were sent out, only 196 of them were returned. This indicates a 78.4% response rate. The assurance that the data collected would be kept confidential and used only for research was relayed to the participants.

4.1.2 Research Instrument

The goal of the study tool was to gather opinions from students about the technical support services for IT offered by DUT. As shown in Table 4.1, the survey questionnaire was split into two sections: Section A, which contained five biographical questions, and Section B, which contained 44 questions intended to gauge the five SERVQUAL aspects. The Likert scale was utilized in the survey's questionnaire to enable the deconstruction of complicated phenomena using linguistic language factors to capture respondents' perceptions. With the use of the closed-ended questions and the 5-point Likert scale, a large sample of respondents' responses could be gathered swiftly and simply. The 44 elements on the study instrument were measured on a nominal or ordinal level.

Table 4.1 SERVQUAL Dimensions by Questionnaire Items

Questionnaire Item	Section
Service Response 1-5	Service Response
Service Assurance 1-5	Service Assurance
Trustworthiness and Loyalty 1-4	Trustworthiness and Loyalty
Commitment 1-5	Commitment
Competence 1-5	Competence

Reputation 1-3	Reputation
Technical Support Staff 1-4	Technical Support Staff
Communication Material 1-3	Communication Material
Method of Communication 1-3	Method of Communication
Location 1-3	Location
Satisfaction Level 1-4	Satisfaction Level

4.1.3 Reliability and Validity Statistics

Validity and reliability are the two most crucial terms utilized to assess the caliber of the research. By performing multiple measurements on the same topics, reliability is calculated. Cronbach's Alpha was calculated to assess the dependability of the data gathered. The Cronbach Alpha scale goes from 0 to 1, with 0 denoting a measurement that is completely unreliable and 1 denoting a value that is completely dependable. For each subscale or dimension of service quality in the survey, the Cronbach Alpha was calculated (results are shown in Table 4.2).

All Cronbach's Alpha coefficients are higher than 0.7, indicating that the questionnaire is a reasonably reliable assessment tool.

The Cronbach's alpha score for each of the questionnaire's items is shown in Table 4.2.

Table 4.2 Cronbach’s Alpha Score for Questionnaire Items

Questionnaire Item	Section	Number of Items	Cronbach's Alpha
Service Response 1-5	Service Response	5	0.825
Service Assurance 1-5	Service Assurance	5	0.793
Trustworthiness and Loyalty 1-4	Trustworthiness and Loyalty	4	0.813
Commitment 1-5	Commitment	5	0.814
Competence 1-5	Competence	5	0.822
Reputation 1-3	Reputation	3	0.802
Technical Support Staff 1-4	Technical Support Staff	4	0.839
Communication Material 1-3	Communication Material	3	0.829
Method of Communication 1-3	Method of Communication	3	0.839
Location 1-3	Location	3	0.810
Satisfaction Level 1-4	Satisfaction Level	4	0.887

4.1.4 Biographical Data Analysis

Following the conclusion of data gathering and evaluation, the data was recorded in a spreadsheet and statistical analyses performed using the Statistical Package for Social Science (SPSS) version 23.0. Where suitable, cross tabulations are utilized to evaluate the criterion across several

independent variables. The outcomes reported in this section were analyzed by using an inferential method that connected correlations found in the collected data with the results of the chi square test. The investigation's research followed conventional reporting guidelines, which requires that a declaration of the statistical significance be made, which in this case is "p < 0.05".

Data is presented in the following format:

4.1.4.1 Descriptive Statistics

Descriptive statistics is the process of organizing and summarizing quantitative data. Descriptive statistics was used to summarize the demographic characteristics of the participants. Descriptive statistics were used to present the data analysis and interpretation. Welman, Kruger and Mitchell (2005) define descriptive statistics as the description and summary of data. Finally, the outcomes of statistical studies are graphically depicted using bar charts or pie charts.

4.1.4.2 Frequency and Percentages

A frequency count, according to McGivern (2006), describes the number of times a value appears in the dataset and the number of respondents who provide a certain answer. Kent (2007) states the percentages are used to reduce the data into a typical numerical range so that it may be compared easily.

4.1.4.3 Demographic Profiles of Respondents

The demographic profile of the respondent, which included information on their age, gender, study type, study level, and department of study, was the first element of the questionnaire survey (Table 4.3).

Table 4.3 Demographic Profiles of Respondents

Characteristics	Category	Frequency	Percentage
Age	17	4	2
	18	16	8.2
	19	17	8.7
	20	23	11.7
	21	38	19.4
	22	18	9.2
	23	26	13.3
	24	19	9.7
	25	12	6.1
	26	10	5.1
	27	1	0.5
	28	3	1.5
	29	1	0.5
	30	1	0.5
	31	0	0

Age	32	1	0.5
	33	3	1.5
	34	1	0.5
	35	2	1
Gender	Male	106	54.1
	Female	90	45.9
Study Type	Part time	12	6.1
	Full time	184	93.9
Study Level	First Year	33	16.8
	Second Year	28	14.3
	Third Year	70	35.7
	Fourth Year	65	33.2
Department	Auditing and Taxation	4	2
	Community Health Studies	1	0.5
	Entrepreneurial Studies and Management	2	1
	Finance and Information Management	1	0.5
	Hospitality and Tourism	4	2
	Human Resources Management	1	0.5
	Information and Corporate Management	14	7.1
	Information Systems	17	8.7
	Information Technology	146	74.5
	Management Accounting	1	0.5
	Maritime Studies	1	0.5
	Medical Orthotics and Prosthetics	2	1
	Sport Studies	2	1

The diagram in Figure 4.1 shows the number of responses by age in a survey. There was a total of 196 responses, and the ages are divided into six categories: 16-17, 18-19, 20-21, 22-23, 24-25, 26-27, and 28+. The largest age group was 22-23, with 38 responses (19.4%). The next largest age group was 18-19, with 23 responses (11.7%). The remaining age groups had the following number of responses: 26-27 (13.3%), 17-19 (9.7%), 20-21 (9.2%), 16-17 (8.2%), and 28+ (5.1%). There were also a small number of responses from people in the following age groups: 29 (1.5%), 30 (1%), 32 (1%), and 34 (1%). Overall, the survey results show that the majority of respondents were in their early 20s. This suggests that this age group is more likely to be interested in the topic of the survey.

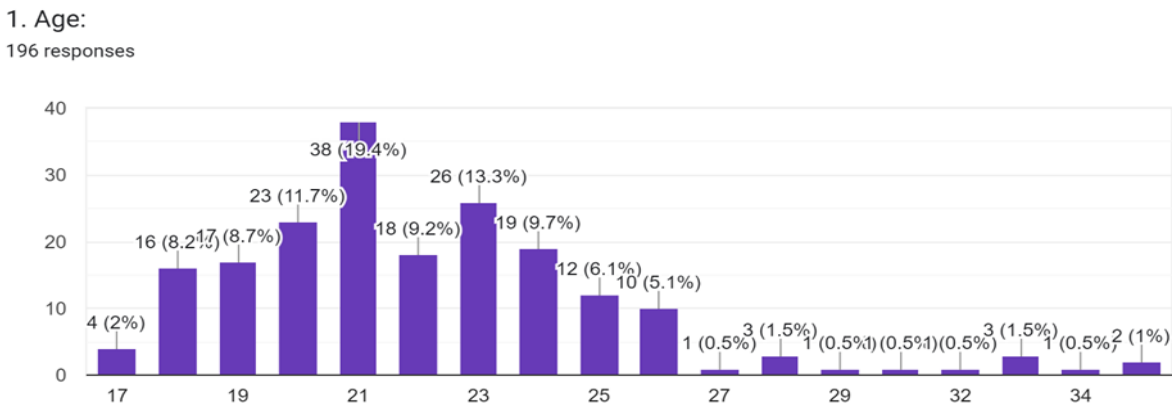

Figure 4.1. Responses Received by Age

The diagram in Figure 4.2 shows the percentage of responses by gender in a survey. There was a total of 196 responses, and the genders are divided into two categories: male and female. The largest gender group was male, with 54.1% of the responses (106 responses). The next largest gender group was female, with 45.9% of the responses (90 responses). This means that there were slightly more male respondents than female respondents in the survey.

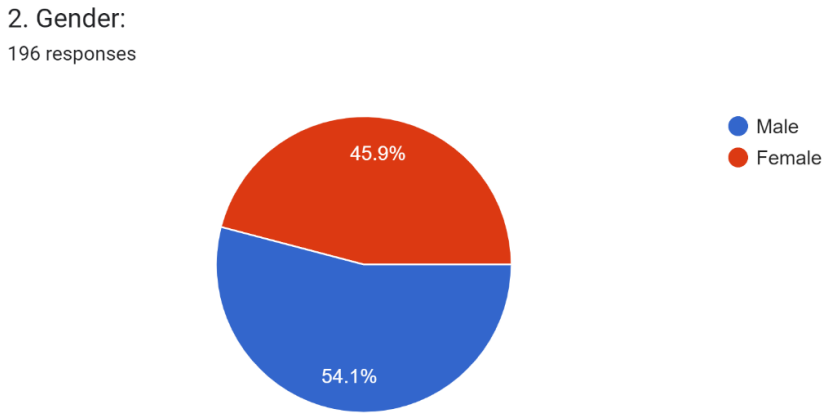

Figure 4.2. Respondents by Gender

The diagram in Figure 4.3 shows the percentage of respondents who work full time and part time in a survey. There was a total of 196 responses, and the employment statuses are divided into two categories: full time and part time. The largest employment status group was full time, with 93.9% of the responses (184 responses). The next largest employment status group was part time, with 6.1% of the responses (12 responses). This means that the vast majority of respondents in the survey work full-time.

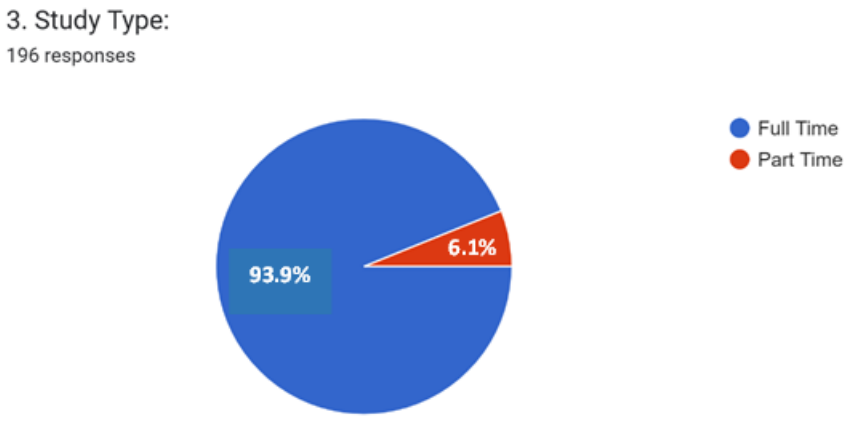

Figure 4.3. Respondents by Study Type

The diagram in figure 4.4 shows the percentage of responses by study level in the survey. There was a total of 196 responses, and the study levels are divided into four categories: first year, second year, third year, and fourth year. The largest study level group was third year, with 35.7% of the responses (70 responses). The next largest study level group was fourth year, with 20% of the responses (39 responses). The remaining study levels had the following number of responses: first year (16.8%) and second year (14.3%). This means that the majority of respondents in the survey are third-year students.

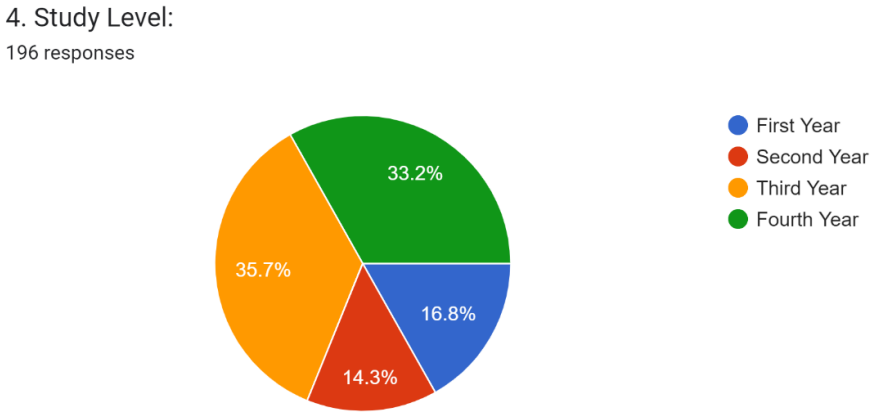

Figure 4.4. Respondents by Study Level

The respondents by department is shown in Figure 4.5. The Department of Information Technology received the most responses (74.5%), followed by Information Systems (8.7%), and Information and Corporate Management (7.1%) in third place. Departments of Auditing and Taxation, as well as Hospitality and Tourism, each have 2%. Medical Orthotics and Prosthetics, Sport Studies and Entrepreneurial Studies and Management with (1%). The Departments of Community Health Studies, Finance and Information Management, Human Resources Management, Management Accounting, and Maritime Studies had the fewest respondents, each with (0.5%).

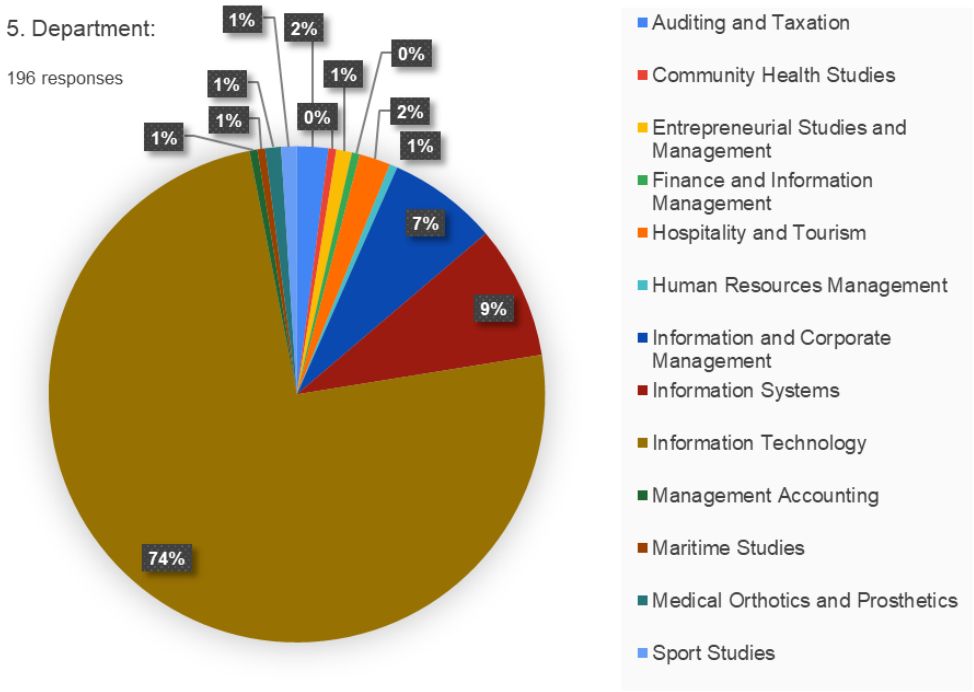

Figure 4.5. Respondents by Department

4.1.5 Survey Results Overview

The next section looks at respondents' ratings for each variable and sector. The findings display the frequency of each statement. The percentage for each statement is indicated in brackets (). The mean and standard deviation of each statement are calculated. The outcomes are next examined taking the statements' relative importance into consideration.

4.1.5.1 Interpretation of Results from Likert-type Scale Data Analysis

Table 4.4 exams the data and reveals that the majority of the respondents seemed to believe that the technical support personnel is devoted to satisfying students. Additionally, the students reported that they always felt welcomed and appreciated. Additionally, students believed that the technical support personnel replied quickly to their emails, calls, and WhatsApp messages. This demonstrates how effective the technical support team is. They thought that technical support kept their word. Students' information is kept private by the technical support staff. There is a perception that technical support personnel are constantly available to help students. The majority of respondents said that technical staff members genuinely cared about resolving their IT-related technical questions. Most students believed that the technical support staff was familiar with their most frequent queries. Students perceived that they were the technical support staff's top focus. Students agreed that the technical support team's expertise and abilities were sufficient to help them with their technical issues. The majority of respondents said that technical staff utilized efficient contemporary web tools and services. Documents distributed to students were thought to be highly helpful and simple to understand.

Students said that the technical staff's manner of communication was highly dependable, very simple to use, and that they were always accessible. The technical support team was seen by the students as playing a crucial role, particularly during the COVID-19 when social distance was necessary. Students were very appreciative of the staff's ability to help them remotely. Tech support was available around-the-clock. Overall, students expressed their gratitude for the IT technical support team's assistance, especially during the pandemic. Students perceived that they could depend on IT technical support to be available if they needed help. The majority of respondents, however, had a negative opinion of the technical staff's ability to keep them informed about computing offers. Take laptop deals, for instance. There was a perception that personnel did not treat students with respect and did not provide them with individualized attention.

Table 4.4 Responses on students' perception of IT technical support services provided

[Service Response]: RESPONSIVENESS

Items (Service Response1-5)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Technical support staff is determined to please students	6(3,1)	12(6,1)	19(9,7)	85(43,4)	74(37,8)	(2,51)	(1,438)	High perception
Students are always welcomed and well received	5(2,6)	3(1,5)	26(13,3)	76(38,8)	86(43,9)	(2,70)	(1,424)	High perception
Technical support staff respond faster to students WhatsApp messages, call or emails	6(3,1)	9(4,6)	46(23,5)	68(34,7)	67(34,2)	(2,66)	(1,339)	High perception
Technical support staff promptly respond to student queries	5(2,6)	3(1,5)	33(16,8)	86(43,9)	69(35,2)	(2,51)	(1,412)	High perception
Technical support staff sends computing service specials via email to regular students	8(4,1)	27(13,8)	32(16,3)	76(38,8)	53(27,0)	(2,44)	(1,348)	Low perception
TOTAL FACTOR SCORE = 2,564								

[Service Assurance]: ASSURANCE

Items (Service Assurance1-5)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Technical support keep to their promises	52(2,6)	4(2,0)	53(27,0)	82(41,8)	52(26,5)	(2,46)	(1,333)	High perception
Staff are courteous with students	5(2,6)	1(0,5)	49(25,0)	91(46,4)	50(25,5)	(2,37)	(1,355)	Low perception
Information is always kept confidential	3(1,5)	2(1,0)	36(18,4)	82(41,8)	73(37,2)	(2,56)	(1,389)	High perception
Technical support staff are always willing to help students	4(2,0)	3(1,5)	33(16,8)	77(39,3)	79(40,3)	(2,64)	(1,398)	High perception

Technical support staff are polite with students	4(2,0)	0(0,0)	39(19,9)	82(41,8)	71(36,2)	(1,98)	(0,931)	Low perception
TOTAL FACTOR SCORE = 2,402								

[Trustworthiness and Loyalty]: EMPATHY

Items (Trustworthiness and Loyalty1-4)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Students impose trust on Technical support staff	2(1,0)	22(11,2)	26(13,3)	86(43,9)	60(30,6)	(2,34)	(1,335)	Low perception
Staff show sincere interest in solving queries	2(1,0)	4(2,0)	42(21,4)	87(44,4)	61(31,1)	(2,42)	(1,351)	High perception
Technical support staff are friendly towards student's sincerity	3(1,5)	6(3,1)	35(17,9)	85(43,4)	67(34,2)	(2,47)	(1,379)	High perception
Technical support staff are aware of students frequently asked questions	3(1,5)	9(4,6)	37(18,9)	86(43,9)	61(31,1)	(2,42)	(1,358)	High perception
TOTAL FACTOR SCORE = 2,4125								

[Commitment]: RESPONSIVENESS

Items (Commitment1-5)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Staff always understand specific needs of students	3(1,5)	12(6,1)	44(22,4)	85(43,4)	52(26,5)	(2,37)	(1,316)	Low perception
Staff always available to assist students	2(1,0)	3(1,5)	55(28,1)	82(41,8)	54(27,6)	(2,44)	(1,306)	Low perception
Technical support staff see students as number one priority	3(1,5)	7(3,6)	62(31,6)	69(35,2)	55(28,1)	(2,57)	(1,269)	High perception
Technical support staff maintain good interaction with students	3(1,5)	6(3,1)	40(20,4)	87(44,4)	60(30,6)	(2,42)	(1,358)	Low perception
Technical support staff give students individual attention	4(2,0)	2(1,0)	39(19,9)	81(41,3)	70(35,7)	(2,38)	(1,301)	Low perception
TOTAL FACTOR SCORE = 2,436								

[Competence]: RELIABILITY

Items (Competence1-5)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Employees take responsibility for errors occurred and quickly reassures student	3(1,5)	11(5,6)	49(25,0)	83(42,3)	50(25,5)	(2,38)	(1,301)	Low perception
Employee act quickly on students' dissatisfactions	3(1,5)	12(6,1)	59(30,1)	75(38,3)	47(24,0)	(2,44)	(1,262)	Low perception

Employee is aware of what to do when students are unhappy	5(2,6)	17(8,7)	54(27,6)	65(33,2)	55(28,1)	(2,58)	(1,276)	High perception
Staff go to great lengths in making sure the student is a "happy customer" at the end of the day	3(1,5)	14(7,1)	40(20,4)	77(39,3)	62(31,6)	(2,49)	(1,330)	Low perception
Staff have appropriate knowledge and skills	3(1,5)	8(4,1)	28(14,3)	68(34,7)	89(45,4)	(2,75)	(1,375)	High perception
TOTAL FACTOR SCORE = 2,528								

[Reputation]: TANGIBILITY

Items (Reputation1-3)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Technical support staff are consistent in terms of service delivery	3(1,5)	6(3,1)	44(22,4)	84(42,9)	59(30,1)	(2,44)	(1,344)	Low perception
Individual service is given to students	3(1,5)	4(2,0)	22(11,2)	94(48,0)	73(37,2)	(2,42)	(1,432)	Low perception
Staff have students' best interest at heart	3(1,5)	9(4,6)	46(23,5)	82(41,8)	56(28,6)	(2,43)	(1,325)	Low perception
TOTAL FACTOR SCORE = 2,43								

[Technical Support Staff]: TANGIBILITY

Items (Technical Support Staff1-4)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Timeliness of solution provided	3(1,5)	7(3,6)	42(21,4)	89(45,4)	55(28,1)	(2,37)	(1,343)	Low perception
Knowledge and skills of personnel	2(1,0)	4(2,0)	21(10,7)	94(48,0)	75(38,3)	(2,42)	(1,428)	Low perception
Effectiveness of solution provided	3(1,5)	2(1,0)	33(16,8)	90(45,9)	68(34,7)	(2,45)	(1,401)	Low perception
Effective use of modern online tools and services	3(1,5)	5(2,6)	27(13,8)	83(42,3)	78(39,8)	(2,56)	(1,411)	High perception
TOTAL FACTOR SCORE = 2,45								

[Communication Material]: TANGIBILITY

Items (Communication Material1-3)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Information provided by support staff is appropriate	2(1,0)	3(1,5)	26(13,3)	97(49,5)	68(34,7)	(2,36)	(1,409)	Low perception
Documents provided are easily accessible and accurate	2(1,0)	2(1,0)	28(14,3)	98(50,0)	66(33,7)	(2,35)	(1,404)	Low perception

Steps provided in the documents are easy to follow	3(1,5)	7(3,6)	29(14,8)	79(40,3)	78(39,8)	(2,59)	(1,395)	High perception
TOTAL FACTOR SCORE = 2,433								

[Method of Communication]: TANGIBILITY

Items (Method of Communication1-3)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Tech staff are easily accessible by WhatsApp service	2(1,0)	9(4,6)	28(14,3)	68(34,7)	89(45,4)	(2,73)	(1,367)	High perception
The WhatsApp service is easy to use	3(1,5)	8(4,1)	17(8,7)	70(35,7)	98(50,0)	(2,78)	(1,411)	High perception
WhatsApp service is reliable	2(1,0)	8(4,1)	31(15,8)	70(35,7)	85(43,4)	(2,70)	(1,365)	High perception
TOTAL FACTOR SCORE = 2,736								

[Location]: TANGIBILITY

Items (Location1-3)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
Remote technical support provided – ideal location especially during the pandemic	3(1,5)	7(3,6)	21(10,7)	75(38,3)	90(45,9)	(2,69)	(1,414)	High perception
Remote technical support is available 24/7	2(1,0)	15(7,7)	33(16,8)	74(37,8)	72(36,7)	(2,56)	(1,344)	High perception
Remote technical support provided is very convenient	2(1,0)	7(3,6)	27(13,8)	77(39,3)	83(42,3)	(2,62)	(1,392)	High perception
TOTAL FACTOR SCORE = 2,623								

[Satisfaction Level]

Items (Satisfaction Level1-4)	**SD (%)**	**D (%)**	**SA (%)**	**A (%)**	**STA (%)**	**Mean**	**σ**	**Decision**
I feel satisfied with the technical support service when I face technical problems.	3(1,5)	7(3,6)	20(10,2)	83(42,3)	83(42,3)	(2,57)	(1,429)	Low perception
I feel satisfied with the IT technical support services provided during the online lecturing/quiz/exam during COVID-19	4(2,0)	6(3,1)	17(8,7)	74(37,8)	95(48,5)	(2,74)	(1,432)	High perception
Are you satisfied with the IT support services provided in case of technical issues that happened during the exam or lecture?	3(1,5)	6(3,1)	21(10,7)	80(40,8)	86(43,9)	(2,62)	(1,425)	High perception
Overall, I am satisfied with the remote technical support service that is being provided.	3(1,5)	5(2,6)	15(7,7)	67(34,2)	106(54,1)	(2,86)	(1,409)	High perception

TOTAL FACTOR SCORE = 2,6975								

Note: *N = 196,* SD = Strongly Disagree; D = Disagree; SA = Slightly Agree; A = Agree; STA = Strongly Agree. σ = standard deviation

Graphically, the SERVQUAL index is therefore as shown in Figure 4.6 and Table 4.5.

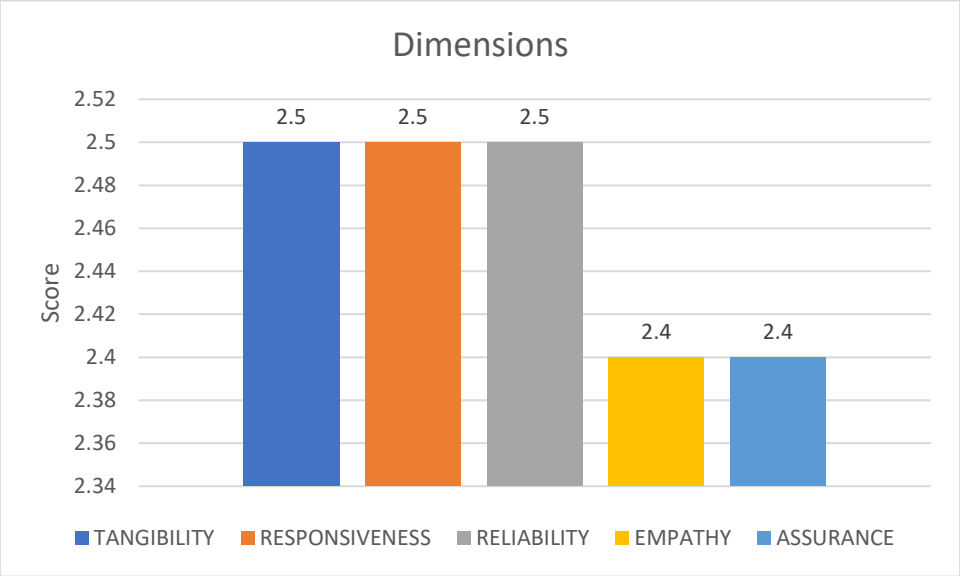

Figure 4.6. SERVQUAL Index per Dimension

Table 4.5 Overall SERVQUAL Index

SERVQUAL DIMENSIONS	SCORE
TANGIBILITY	2.5
RESPONSIVENESS	2.5
RELIABILITY	2.5
EMPATHY	2.4
ASSURANCE	2.4
OVERALL SERVQUAL	**3.0**

4.1.5.2 Results are Examined According to Statements' Importance

The results received by students for each of the statements in the survey questionnaire is elaborated.

4.1.5.2.1 Service Response

Service Response consists of 5 questions in the questionnaire. Figure 4.7 presents the results received by students. 43.4% of the students concurred that technical support personnel were eager to please them. 37.8% of respondents strongly agreed that customer satisfaction has been the

support staff's top priority, whereas 9.7% slightly agreed, 6.1% disagreed, and 3.1% undoubtedly disagreed.

38.8% of the students agreed that they are always welcomed and well accepted, whereas 43.9% of the students believed the technical support staff welcomed and appreciated them. 13.3% of respondents felt they were welcomed, but not in the way they had hoped. While 1.5% of students disagreed with being cordially accepted and welcomed by the technical staff, the remaining 2.6% of students firmly believed they were never welcomed and appreciated.

Technical support staff reacted to students' WhatsApp messages, calls, or emails far more quickly, according to 34.7% and 34.2% of students, respectively, while 23.5% of students somewhat agreed. 3.1% of the students strongly disagreed, while 4.6% of the students opposed partially that technical staff was responding to their emails, calls, or WhatsApp messages quicker than usual.

43.9% of students said that they were satisfied with the technical support team's response time, while 35.2% of students agreed that the team members answered quickly to their queries. 16.8% of respondents said they were just mildly satisfied with the technical support team's response time. 1.5% disagreed, while 2.6% found the technical support team's response time to be completely unacceptable.

38.8% of the students agreed that they received WhatsApp messages informing them of computing sales discounts. 27% firmly concurred that technical personnel had been sending them emails and other communications regarding computer deals promoted by other computing businesses. 16.3% agreed that they have been receiving computing specials from technical employees. 13.8% were against it. However, 4.1% of students strongly concurred that the technical staff had not been giving them any computing specials, and they felt they may have been missing out on a number of specials from which they may have benefited.

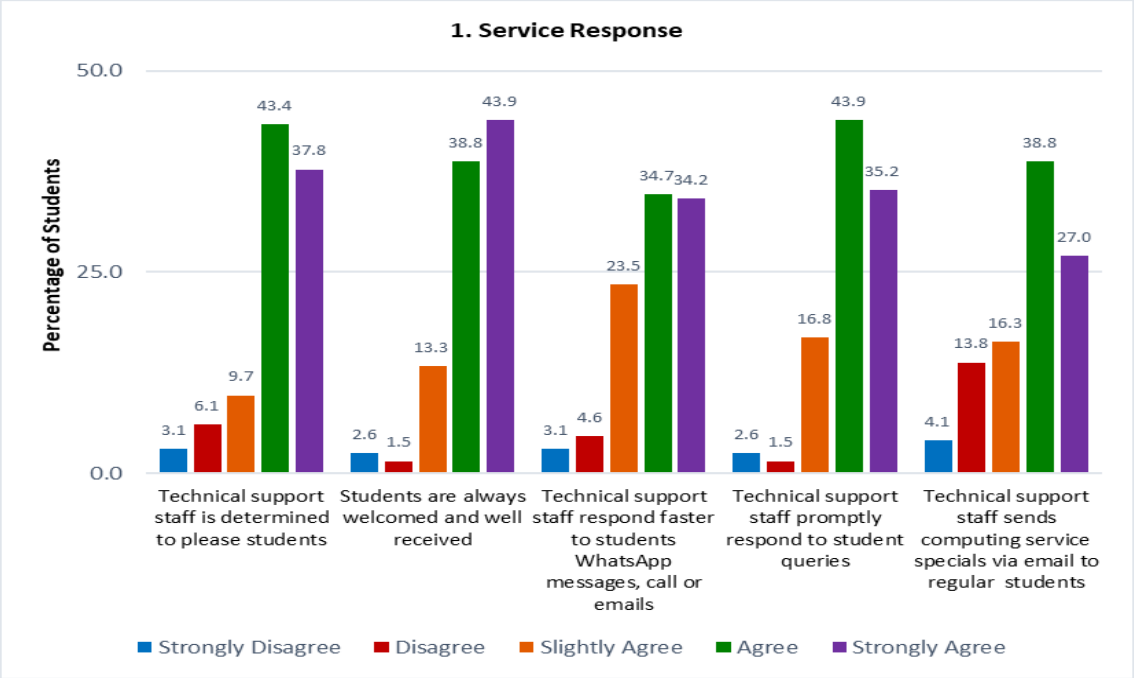

Figure 4.7. Responses on Service Response

4.1.5.2.2 Service Assurance

Service Assurance consists of 5 questions in the survey questionnaire. Figure 4.8 represents the results for each question. 41.8% of the students said that technical support adhered to their promises. 41.8% of the students believed that the technical support staff maintained the confidentiality of personal information. 40.3% of respondents believed that technical support staff were always willing to assist students. While 5% vehemently disagreed that they were treated courteously and politely by technical support personnel.

Figure 4.8. Responses on Service Assurance

4.1.5.2.3 Trustworthiness and Loyalty

Trustworthiness and Loyalty consists of 4 questions in the survey questionnaire. Figure 4.9 represents the results for each of the questions. In response to 44.4% of respondents, technical staff members genuinely cared about resolving their technical IT concerns. 43.9% of the students responded that the technical support staff had the answers to their most common queries. 43.4% of the students responded that the technical support staff valued their sincerity.

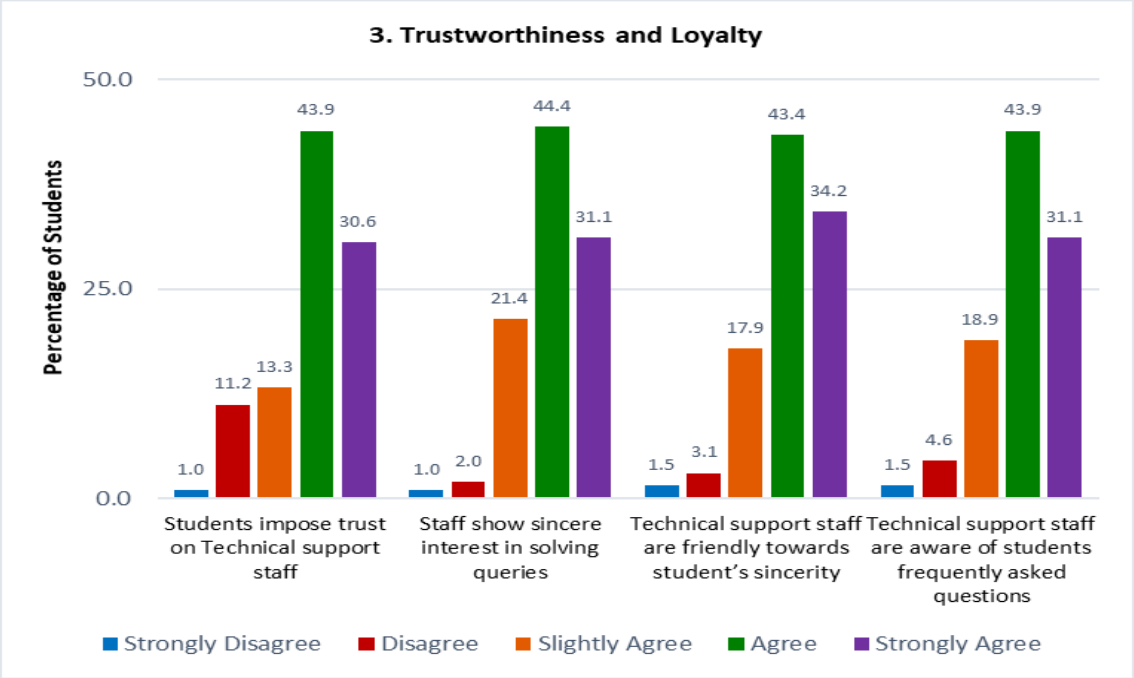

Figure 4.9. Responses on Trustworthiness and Loyalty

4.1.5.2.4 Commitment

Commitment consists of 5 questions in the survey questionnaire. Figure 4.10 represents the results for each of the questions. 35.2% of students perceived that they were the technical support staff's first priority. However, there were 12% that were under the perception that personnel did not treat students with respect, staff did not understand students' specific needs and did not provide them with individualized attention.

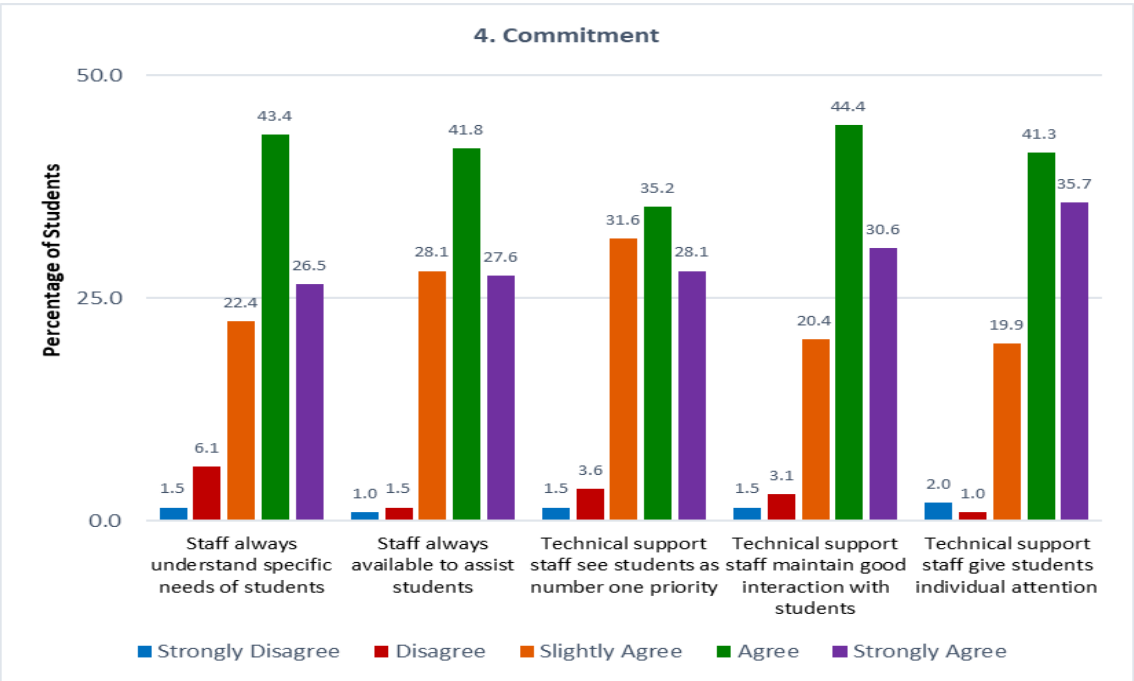

Figure 4.10. Responses on Service Commitment

4.1.5.2.5 Competence

Competence consists of 5 questions in the survey questionnaire. Figure 4.11 represents the results for each of the questions. 45.4% felt that the technical support team's knowledge and skills were deemed sufficient by the students to assist them with their technological problems. When a laptop needed repair, the technical support team moved rapidly because students are given priority by the personnel.

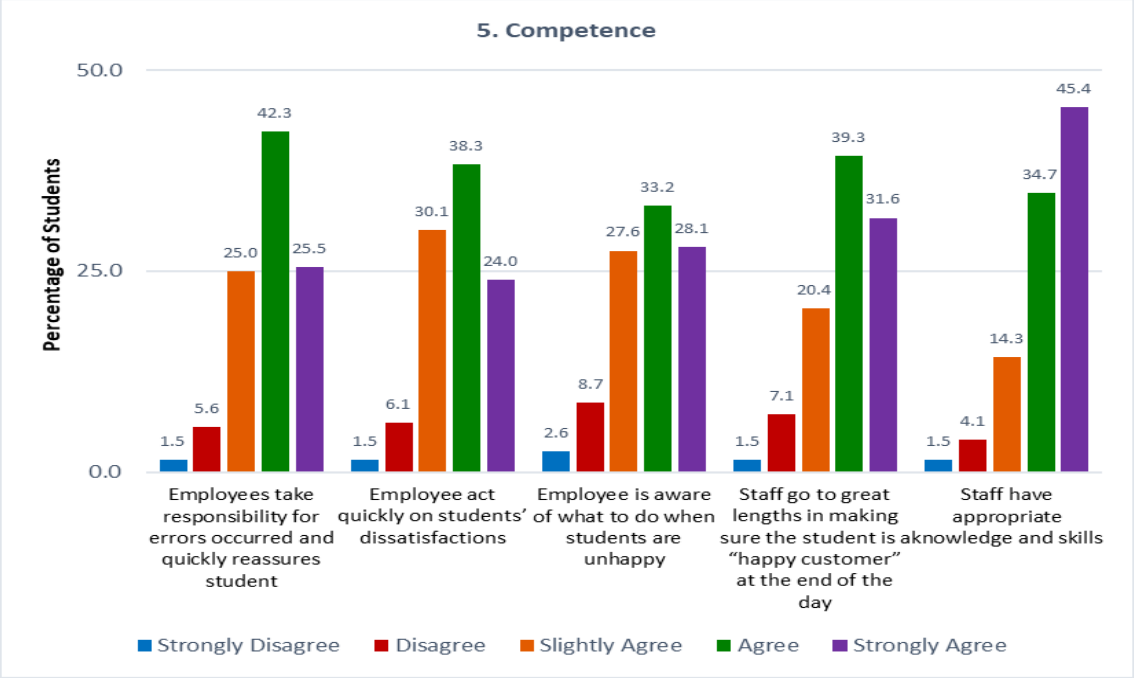

Figure 4.11. Responses on Staff Competence

4.1.5.2.6 Reputation

Reputation consists of 3 questions in the survey questionnaire. Figure 4.12 represents the results for the each of the questions. Students had negative impressions of the technical support staff's reliability in providing services, tailored care for each student, and commitment to the welfare of the students.19% disagreed and 9% strongly disagreed.

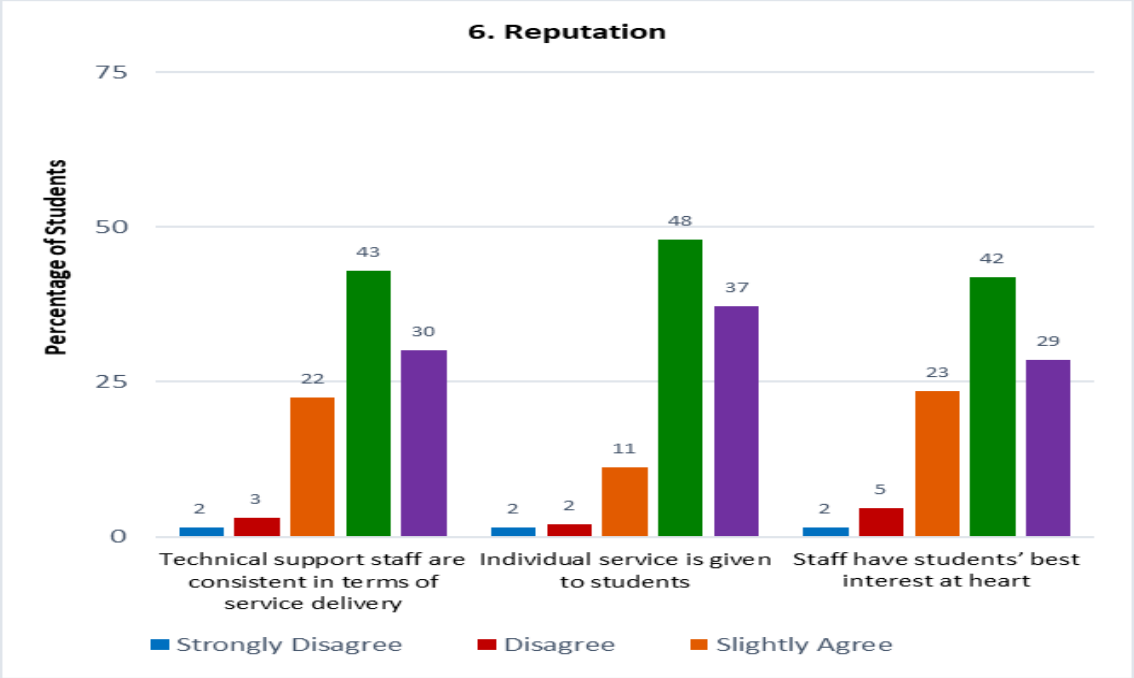

Figure 4.12. Responses on Reputation

4.1.5.2.7 Technical Support Staff

Technical Support staff consists of 4 questions in the survey questionnaire. Figure 4.13 represents the results for the each of the questions. According to 42.3% of respondents, technical staff members effectively used modern web tools and services. 1.5% of students said that they felt the time it took for them to receive solutions was too long and that the solutions that were offered to them were ineffective.

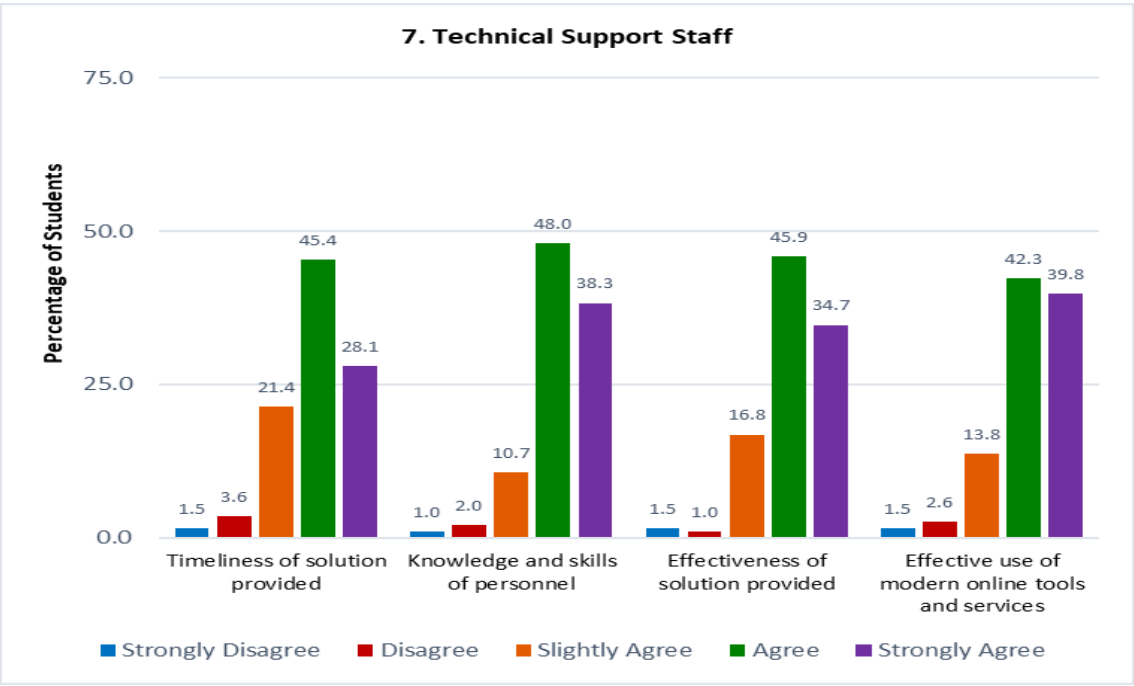

Figure 4.13. Responses on Technical Support Staff

4.1.5.2.8 Communication Material

Communication material consists of 3 questions in the survey questionnaire. Figure 4.14 represents the results for the each of the questions. 49.5% of students said the knowledge they received was helpful to them. 50% thought the informational and simple-to-understand items were excellent. The documents that were distributed, in the opinion of 40.3%, were simple to understand.

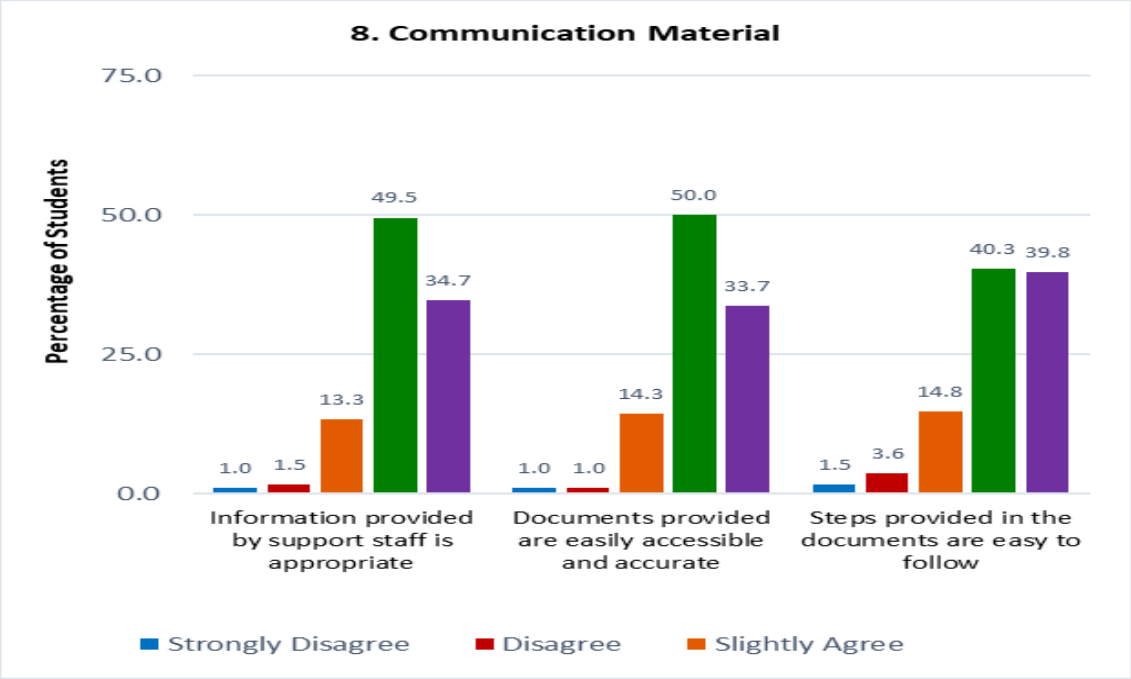

Figure 4.14. Responses on Communication Material Provided

4.1.5.2.9 Method of Communication

Communication material consists of 3 questions in the survey questionnaire. Figure 4.15 represents the results for the each of the questions. The WhatsApp platform that the technical support personnel used was perceived by 45.4% of the students as making them accessible. 50% of respondents thought it was extremely simple to use WhatsApp. 43.4% thought the service was reliable.

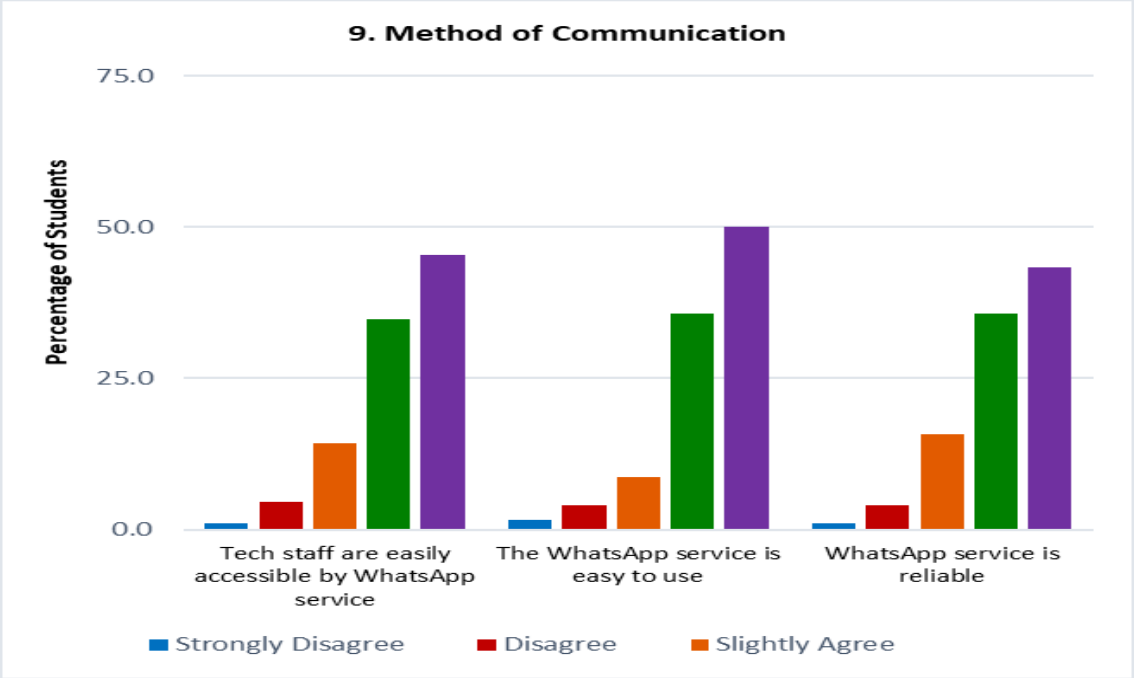

Figure 4.15. Responses on Method of Communication

4.1.5.2.10 Location

Location consists of 3 questions in the survey questionnaire. Figure 4.16 represents the results for the each of the questions. The assistance provided by the technical support team, according to 45.9% of students, was crucial, particularly during the COVID-19 when it was vital to maintain social distancing. The staff's ability to provide students with remote assistance was widely valued by the students. 39.3% of students said it was helpful that technical support personnel was available round-the-clock via the WhatsApp technical support center. 42.3% of respondents said they found the remote technical support they received to be extremely convenient.

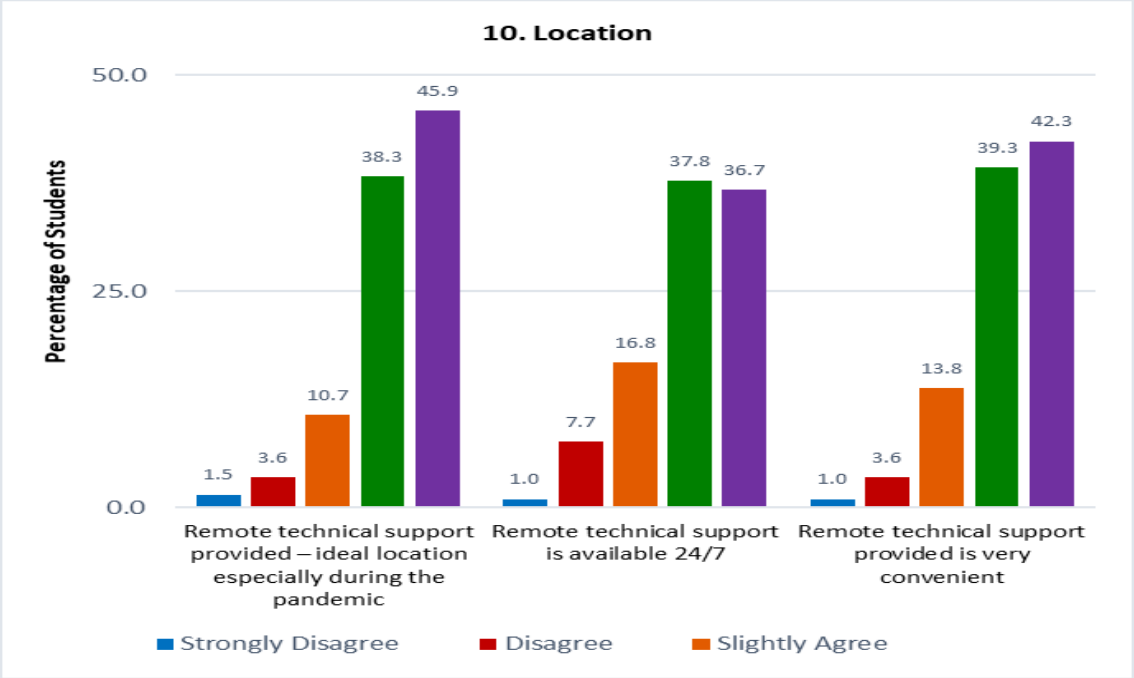

Figure 4.16. Responses on Location Convenience

4.1.5.2.11 Satisfaction Level

Satisfaction Level consists of 4 questions in the survey questionnaire. Figure 4.17 represents the results for the each of the questions. High perceptions were felt in terms of the support services provided during online lecturing/quiz/exam during the pandemic (48.5%), in cases of technical issues students experienced during lecture or exam(43.9%). 54.1% of students said they were grateful for the IT technical support team's assistance, especially during the pandemic. Students had the impression that they could count on IT technical support to be available if they needed help. Students felt more at ease using the online remote learning method because the technical support staff was always available to address their questions.

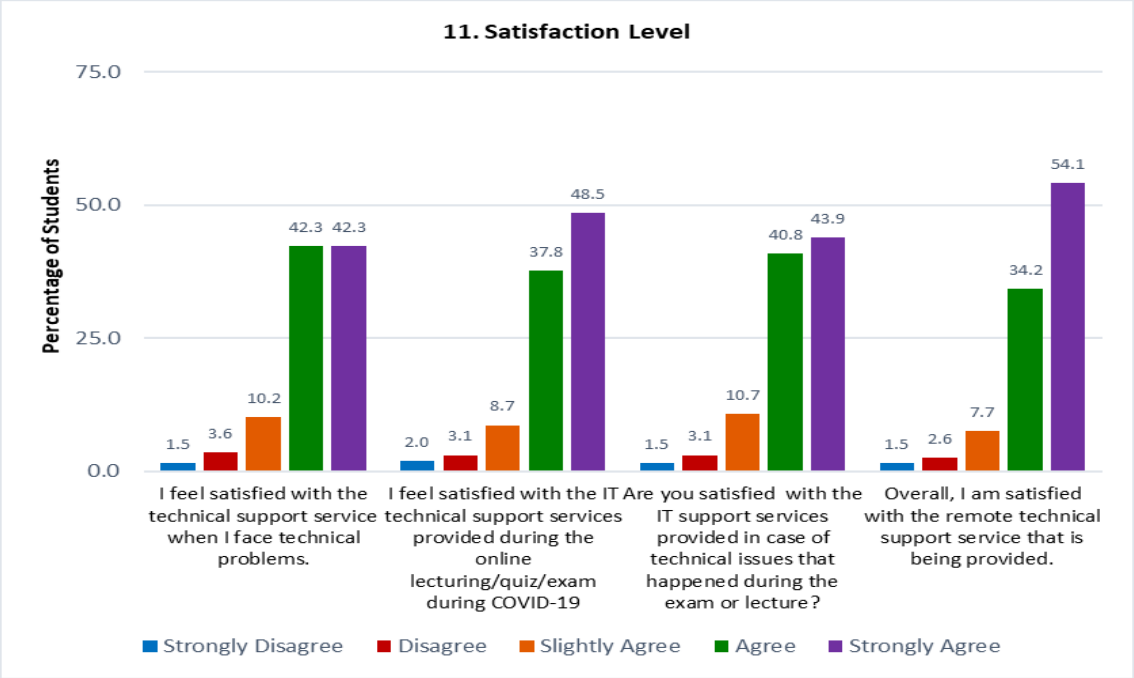

Figure 4.17. Responses on Satisfaction Level

4.1.6 Cross Tabulations

Cross-tabulations, also known as contingency tables, involve tabulating the frequency or distribution of one categorical variable against another. Since this study involves evaluating satisfaction levels with IT technical support services, a few cross-tabulations for various factors that could influence satisfaction are examined. Here are a few cross-tabulations the researcher has considered:

a. Satisfaction Level vs. Age: Examining the relationship between students' satisfaction levels and their age. The goal is to understand how satisfaction varies among different age groups.

b. Satisfaction Level vs. Study Level: Cross-tabulate satisfaction levels against the year of study (e.g., first, second, third or fourth year) to see if satisfaction varies by the academic year of the students.

c. Satisfaction Level vs. Gender: Comparing the satisfaction levels of male and female students using a cross-tabulation. This might help identify if there is any gender-based pattern in satisfaction levels.

4.1.6.1 Satisfaction Level vs. Age

As depicted in Table 4.6, the overall satisfaction level is 42.3%, with 20% strongly agreeing and 10.2% agreeing that they are satisfied with the technical support service. There is a significant variation in satisfaction levels by age group. People aged 17-18 are the least satisfied, with only 10% strongly

agreeing or agreeing with the statement that they are satisfied with the technical support service. People aged 22-23 are the most satisfied, with 30.8% strongly agreeing or agreeing with the statement. However, there is a general trend of increasing satisfaction with age, with people aged 24-25 and 26-27 also having relatively high satisfaction levels.

Furthermore, the cell with the highest value is (22-23, Strongly Agree), which means that 30.8% of people aged 22-23 strongly agree that they are satisfied with the technical support service. The cell with the lowest value is (17, Strongly Agree), which means that only 2% of people aged 17 strongly agree that they are satisfied with the technical support service. There is a positive correlation between age and satisfaction level, which means that satisfaction level tends to increase with age. The relationship between age and satisfaction level is statistically significant, which means that the difference in satisfaction levels between different age groups is not due to chance. Overall, the cross-tabulation table shows that satisfaction with technical support services varies by age group. However, most people are at least somewhat satisfied with the service.

Table 4.6 Satisfaction Level vs. Age

Crosstab

			11. Satisfaction Level [I feel satisfied with the technical support service when I face technical problems.]					
			Agree	Disagree	Slightly Agree	Strongly Agree	Strongly Disagree	Total
1. Age:	17	Count	2	0	0	2	0	4
		% of Total	1,0%	0,0%	0,0%	1,0%	0,0%	2,0%
	18	Count	11	0	2	2	1	16
		% of Total	5,6%	0,0%	1,0%	1,0%	0,5%	8,2%
	19	Count	10	1	0	6	0	17
		% of Total	5,1%	0,5%	0,0%	3,1%	0,0%	8,7%
	20	Count	11	1	4	7	0	23
		% of Total	5,6%	0,5%	2,0%	3,6%	0,0%	11,7%
	21	Count	16	3	4	15	0	38
		% of Total	8,2%	1,5%	2,0%	7,7%	0,0%	19,4%
	22	Count	7	0	1	10	0	18
		% of Total	3,6%	0,0%	0,5%	5,1%	0,0%	9,2%
	23	Count	4	0	3	17	2	26
		% of Total	2,0%	0,0%	1,5%	8,7%	1,0%	13,3%
	24	Count	5	1	3	10	0	19
		% of Total	2,6%	0,5%	1,5%	5,1%	0,0%	9,7%
	25	Count	9	0	1	2	0	12
		% of Total	4,6%	0,0%	0,5%	1,0%	0,0%	6,1%
	26	Count	4	0	0	6	0	10
		% of Total	2,0%	0,0%	0,0%	3,1%	0,0%	5,1%
	27	Count	0	0	0	1	0	1
		% of Total	0,0%	0,0%	0,0%	0,5%	0,0%	0,5%
	28	Count	0	1	0	2	0	3
		% of Total	0,0%	0,5%	0,0%	1,0%	0,0%	1,5%
	29	Count	1	0	0	0	0	1
		% of Total	0,5%	0,0%	0,0%	0,0%	0,0%	0,5%
	30	Count	1	0	0	0	0	1
		% of Total	0,5%	0,0%	0,0%	0,0%	0,0%	0,5%
	32	Count	0	0	1	0	0	1
		% of Total	0,0%	0,0%	0,5%	0,0%	0,0%	0,5%
	33	Count	1	0	0	2	0	3
		% of Total	0,5%	0,0%	0,0%	1,0%	0,0%	1,5%
	34	Count	0	0	0	1	0	1
		% of Total	0,0%	0,0%	0,0%	0,5%	0,0%	0,5%
	42	Count	1	0	1	0	0	2
		% of Total	0,5%	0,0%	0,5%	0,0%	0,0%	1,0%
Total		Count	83	7	20	83	3	196
		% of Total	42,3%	3,6%	10,2%	42,3%	1,5%	100,0%

4.1.6.2. Satisfaction Level vs. Study Level

The overall satisfaction level is 42.3%, as depicted in Table 4.7, with 20% strongly agreeing and 10.2% agreeing that they are satisfied with the technical support service. There is a significant variation in satisfaction levels by study level. First-year students are the least satisfied, with only 7.1% strongly agreeing or agreeing with the statement that they are satisfied with the technical support service. Fourth-year students are the most satisfied, with 33.2% strongly agreeing or agreeing with the statement. However, there seems to be a general trend of increasing satisfaction with study level, with second year and third-year students also having relatively high satisfaction levels.

Furthermore, the cell with the highest value is (Fourth Year, Strongly Agree), which means that 33.2% of fourth-year students strongly agree that they are satisfied with the technical support service. The cell with the lowest value is (First Year, Strongly Agree), which means that only 7.1% of first-year students strongly agree that they are satisfied with the technical support service. There is a positive correlation between study level and satisfaction level, which means that satisfaction level tends to increase with study level. The relationship between study level and satisfaction level is statistically significant, which means that the difference in satisfaction levels between different study levels is not due to chance.

Table 4.7 Satisfaction Level vs. Study Level

4. Study Level: * 11. Satisfaction Level [I feel satisfied with the technical support service when I face technical problems.] Crosstabulation

			11. Satisfaction Level [I feel satisfied with the technical support service when I face technical problems.]					
			Agree	Disagree	Slightly Agree	Strongly Agree	Strongly Disagree	Total
4. Study Level:	First Year	Count	14	3	3	12	1	33
		% of Total	7,1%	1,5%	1,5%	6,1%	0,5%	16,8%
	Fourth Year	Count	23	2	4	34	2	65
		% of Total	11,7%	1,0%	2,0%	17,3%	1,0%	33,2%
	Second Year	Count	19	0	2	7	0	28
		% of Total	9,7%	0,0%	1,0%	3,6%	0,0%	14,3%
	Third Year	Count	27	2	11	30	0	70
		% of Total	13,8%	1,0%	5,6%	15,3%	0,0%	35,7%
Total		Count	83	7	20	83	3	196
		% of Total	42,3%	3,6%	10,2%	42,3%	1,5%	100,0%

4.1.6.3. Satisfaction Level vs. Gender

As depicted in Table 4.8, the overall satisfaction level is 42.3%, with 20% strongly agreeing and 10.2% agreeing that they are satisfied with the technical support service. There is a significant variation in satisfaction levels by gender. Men are more satisfied than women, with 45.9% of men strongly agreeing or agreeing with the statement that they are satisfied with the technical support service, compared to 39.1% of women. The difference in satisfaction levels between men and women is statistically significant.

Furthermore, the cell with the highest value is (Male, Strongly Agree), which means that 21.9% of men strongly agree that they are satisfied with the technical support service. The cell with the lowest value is (Female, Disagree), which means that only 2.6% of women disagree with the statement that they are satisfied with the technical support service. There is a positive correlation between gender and satisfaction level, which means that satisfaction level tends to be higher for men than for women. Overall, the cross-tabulation table shows that there is a significant difference in satisfaction with technical support services between men and women. Men are more satisfied than women, and the difference is statistically significant.

Table 4.8 Satisfaction Level vs. Gender

Crosstab

			11. Satisfaction Level [I feel satisfied with the technical support service when I face technical problems.]					
			Agree	Disagree	Slightly Agree	Strongly Agree	Strongly Disagree	Total
2. Gender:	Female	Count	40	1	7	41	1	90
		% of Total	20,4%	0,5%	3,6%	20,9%	0,5%	45,9%
	Male	Count	43	6	13	42	2	106
		% of Total	21,9%	3,1%	6,6%	21,4%	1,0%	54,1%
Total		Count	83	7	20	83	3	196
		% of Total	42,3%	3,6%	10,2%	42,3%	1,5%	100,0%

4.1.7 Chi-square Tests by Pearson

The chi-square test is a statistical test that is used to determine whether there is a statistically significant relationship between two categorical variables. The chi-square test results as can be seen in Table 4.9 show that there is a statistically significant relationship between the following pairs of variables:

Age and Service Response (p-value < 0.001)

Study Level and Service Response (p-value < 0.001)

Department and Trustworthiness and Loyalty (p-value < 0.001)

Department and Reputation (p-value < 0.001)

Department and Technical Support Staff (p-value < 0.001)

Department and Communication Material (p-value < 0.001)

The results show that there is a statistically significant relationship between age and service response. The percentage of people who are satisfied with the technical support service is higher for older users than for younger users. This suggests that the relationship between age and service response is positive. To determine the strength of the relationship, we can look at the chi-square value. The chi-square value is a measure of how much the observed distribution of the responses differs from the expected distribution of the responses. The larger the chi-square value, the stronger the relationship between the two variables. In this case, the chi-square values are all very large, which suggests that the relationships between the variables are all strong.

Table 4.9 Chi-square Tests by Pearson

Variable Pairs	Chi-Square	df	Asymptotic Significance
Age * Service Response 5	110,020	68	<0.001
Study Level * Service Response 3	43,283	12	<0.001
Department * Trustworthiness and Loyalty 2	87,356	48	<0.001
Department * Reputation 1	109,143	48	<0.001
Department * Technical Support Staff 4	215,952	48	<0.001
Department * Communication Material 3	121,848	48	<0.001

4.2 Fuzzy TOPSIS Results

This section exhibits the outcomes of the Fuzzy TOPSIS software used in conjunction with MATLAB R2023a and provides full descriptions of the inputs and outputs of the application. The sophisticated mathematical equations used in the backend of this software are compatible with the Fuzzy TOPSIS approach outlined in Section 3.3.4.2. The decisions were made based on the preferences of the decision-makers, who had contacted the IT support team via the WhatsApp IT technical support centre.

The fuzzy rating scale, which uses the linguistic phrases Very Poor (VP), Poor (P), Fair (F), Good (G), and Very Good (VG) as a fuzzy triple and integers in the range of 1 to 9, is shown in Table 4.10. The criteria are rated using these language expressions. Table 4.11 indicates the measures for criteria.

Table 4.10 Linguistic and Fuzzy Triple for Rating Criteria

Linguistic Term	**Membership Function**
Very Poor (VP)	**(1,1,3)**
Poor (P)	**(1,3,5)**
Fair (F)	**(3,5,7)**
Good (G)	**(5,7,9)**
Very Good (VG)	**(7,9,9)**

Table 4.11 Measures for Criteria

CRITERIA	
C1	Responsiveness
C2	Assurance
C3	Reliability
C4	Empathy
C5	Tangibility
C6	Satisfaction Level

The variables for IT technical support services that have been compiled from the existing literature are shown in Table 3.3. The criteria that will be utilized to choose the sub-criteria for university students are represented by the symbols C1 through C6.

The six criteria were rated linguistically by ten university-level IT technical experts, as shown in Table 4.12. The symbols D1 through D10 in the table show their input values.

Table 4.12 Linguistic and Fuzzy Triple for Criteria

Linguistic values	C1: RESPONSIVENESS										C2: ASSURANCE					C3: EMPATHY					C4: RELIABILITY					C5:TANGIBILITY																C6: SATISFACTION LEVEL			
D1	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
D2	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG
D3	G	G	G	VG	G	F	F	F	F	F	G	G	VG	VG	G	F	F	P	F	VG	G	VG	VG	VG	VG	VG	VG	G	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	G	VG	VG	VG
D4	G	VG	VG	VG	G	F	G	F	F	F	G	G	G	G	G	G	VG	G	G	F	G	F	G	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
D5	G	G	P	G	VG	G	G	G	G	G	F	VG	VG	VG	VG	G	G	G	G	F	G	F	G	G	G	G	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G	G	G	G	G
D6	VG	VG	VG	G	G	VG	G	VG	VG	G	VG	G	VG	VG	VG	G	VG	VG	VG	G	VG	VG	VG	VG	VG	G	G	G	G	G	G	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	G	VG	VG	VG
D7	G	G	F	G	P	G	G	P	F	F	F	G	F	G	G	F	F	G	G	VG	G	F	P	VG	VG	G	F	G	VG	VG	F	G	G	P	P	VP	VP	F	G	P	VG	F	G	F
D8	VG	VG	VG	VG	VG	G	G	VG	VG	VG	VG	VG	VG	VG	G	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	G	G	G	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG
D9	VG	VG	VG	VG	VG	F	F	F	F	F	F	F	F	F	F	F	F	F	F	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	VG	F	F	F	F	F	F	F	F	F	F	F	F
D10	G	G	F	F	P	P	G	F	VG	VG	VG	F	G	VG	VG	G	VG	VG	G	G	F	G	F	VG	F	VG	G	F	G	F	VG	F	G	G	VG	VG	G	VG	F	VG	F	G	G	VG

The Best Non-Fuzzy Performance value (BNP) for a criterion weighting j, is calculated using the following equation (Lee and Lee 2021):

$$DF_{\widetilde{\omega}_i} = BNP_{\widetilde{\omega}_i} \cong \frac{1}{3}\left(L_{\widetilde{\omega}_i} + M_{\widetilde{\omega}_i} + U_{\widetilde{\omega}_i}\right) \qquad (4.1)$$

The relative relevance of the criterion is shown by the BNP values. The total scores for each criterion are displayed in Table 4.13. Equation 4.1 was used to compute the BNP value for each criterion, which is also shown in Table 4.13. According to the explanations provided in Table 4.10, linguistic weights were applied based on the BNP values.

Table 4.13 Aggregated Scores and BNP values for Criteria

Criteria	Aggregated Fuzzy Score	BNP Value	Linguistic Weight
C1	1,6.905102,9	5.635034	G

C2	1,7.029592,9	5.676531	G
C3	1,6.956633,9	5.652211	G
C4	1,6.758163,9	5.586054	G
C5	1,7.212372,9	5.737457	G
C6	1,7.5,9	5.833333	G

The ranking of the criteria according to the BNP values shown in Table 4.13 is shown in Table 4.14.

According to Table 4.14, the expert decision-makers gave C6 (Satisfaction Level) the highest ranking among the criteria. After C2 (Assurance), C3 (Reliability), and C1 (Responsiveness), C5 (Tangibility) is the second-highest suggested requirement. The decision-makers' least favorite criterion is C4 (Empathy).

Table 4.14 Ranked Criteria based on BNP values

Ranked Criteria	
1	C6
2	C5
3	C2
4	C3
5	C1
6	C4

The fuzzy rating scale for weighing the sub-criteria is displayed in Table 4.15. Strongly Disagree (SD), Disagree (D), Slightly Agree (SA), Agree (A), and Strongly Agree (STA) are linguistic terms that are expressed as fuzzy triples with integers ranging from 1 to 9.

Table 4.15 Linguistic and Fuzzy Triple for Sub-Criteria

Linguistic Term	**Membership Function**
Strongly Disagree (SD)	**(1,1,3)**
Disagree (D)	**(1,3,5)**
Slightly Agree (SA)	**(3,5,7)**
Agree (A)	**(5,7,9)**
Strongly Agree (STA)	**(7,9,9)**

The Sub-Criteria numeric labels are displayed in Table 4.16.

Table 4.16 Numeric Labels for the Sub-Criteria

SUB-CRITERIA	
A1	Service Response
A2	Service Assurance
A3	Trustworthy and Loyalty
A4	Commitment
A5	Competence
A6	Reputation
A7	Technical Support Staff
A8	Communication Material
A9	Method of Communication
A10	Location
A11	Satisfaction Level

196 student decision-makers evaluated the six criteria using the linguistic terms listed in Table 4.15, and the results are presented in Table 4.17.

Table 4.17 Assigned Rating by Decision-Makers

Sub-Criteria	1. Service Response [Technical support staff is determined to please students]	1. Service Response [Students are always welcomed and well received]	1. Service Response [Technical support staff respond faster to students WhatsApp	1. Service Response [Technical support staff promptly respond to student queries]	1. Service Response [Technical support staff sends computing service specials via email to	4. Commitment [Staff always understand specific needs of students]	4. Commitment [Staff always available to assist students]	4. Commitment [Technical support staff see students as number one	4. Commitment [Technical support staff maintain good interaction	4. Commitment [Technical support staff give students individual attention]
DM1	A	A	A	A	SA	A	A	A	A	A
DM2	STA	STA	STA	STA	STA	STA	STA	STA	STA	STA
DM3	A	A	A	STA	A	SA	SA	SA	SA	SA
DM4	A	STA	STA	STA	A	SA	A	SA	SA	SA
DM5	A	A	D	A	STA	A	A	A	A	A
DM6	STA	STA	STA	A	A	STA	A	STA	STA	A
.....										
DM194	STA	STA	SA	A	A	A	A	A	A	A
DM195	A	A	SA	A	SA	A	A	A	A	A
DM196	A	SA	SA	STA	STA	A	STA	SA	STA	STA

The Normalized Fuzzy Decision Matrix from the MATLAB R2023a application is presented in Table 4.18. Equation 3.8 was used to produce this matrix.

Table 4.18 Normalized Fuzzy Decision Matrix

A1	[0.111111111111111	0.792517007	1]
A2	[0.111111111111111	0.821995465	1]

A3	[0.111111111111111	0.760770975	1]
A4	[0.111111111111111	0.79478458	1]
A5	[0.111111111111111	0.713151927	1]
A6	[0.111111111111111	0.749433107	1]
A7	[0.111111111111111	0.763038549	1]
A8	[0.111111111111111	0.743764172	1]
A9	[0.111111111111111	0.776643991	1]
A10	[0.111111111111111	0.79478458	1]
A11	[0.111111111111111	0.750566893	1]
A12	[0.111111111111111	0.759637188	1]
A13	[0.111111111111111	0.804988662	1]
A14	[0.111111111111111	0.80952381	1]
A15	[0.111111111111111	0.800453515	1]
A16	[0.111111111111111	0.759637188	1]
A17	[0.111111111111111	0.783446712	1]
A18	[0.111111111111111	0.790249433	1]
A19	[0.111111111111111	0.774376417	1]
A20	[0.111111111111111	0.743764172	1]
A21	[0.111111111111111	0.72675737	1]
A22	[0.111111111111111	0.723356009	1]
A23	[0.111111111111111	0.760770975	1]
A24	[0.111111111111111	0.818594104	1]
A25	[0.111111111111111	0.770975057	1]
A26	[0.111111111111111	0.816326531	1]
A27	[0.111111111111111	0.758503401	1]
A28	[0.111111111111111	0.766439909	1]
A29	[0.111111111111111	0.823129252	1]
A30	[0.111111111111111	0.802721088	1]
A31	[0.111111111111111	0.814058957	1]
A32	[0.111111111111111	0.811791383	1]

A33	[0.111111111111111	0.80952381	1]
A34	[0.111111111111111	0.807256236	1]
A35	[0.111111111111111	0.819727891	1]
A36	[0.111111111111111	0.841269841	1]
A37	[0.111111111111111	0.814058957	1]
A38	[0.111111111111111	0.829931973	1]
A39	[0.111111111111111	0.781179138	1]
A40	[0.111111111111111	0.818594104	1]
A41	[0.111111111111111	0.823129252	1]
A42	[0.111111111111111	0.839002268	1]
A43	[0.111111111111111	0.827664399	1]
A44	[0.111111111111111	0.859410431	1]

The results for FNIS and FPIS produced by the MATLAB R2023a application using Equations 3.12 and 3.11, respectively, are displayed in Table 4.19.

Table 4.19 FNIS and FPIS

	FNIS			**FPIS**		
A1	[0.555555555555556	4.992063492	9]	[0.555555555555556	5.753968254	9]
A2	[0.555555555555556	5.206349206	9]	[0.555555555555556	5.563492063	9]
A3	[0.555555555555556	5.317460317	9]	[0.555555555555556	5.666666667	9]
A4	[0.555555555555556	5.063492063	9]	[0.555555555555556	5.73015873	9]
A5	[0.333333333333333	3.792517007	7]	[0.333333333333333	4.115646259	7]
A6	[0.555555555555556	5.650793651	9]	[0.555555555555556	5.888888889	9]
A7	[0.555555555555556	5.468253968	9]	[0.555555555555556	5.873015873	9]
A8	[0.555555555555556	5.325396825	9]	[0.555555555555556	6.015873016	9]
A9	[0.555555555555556	4.992063492	9]	[0.555555555555556	5.563492063	9]
A10	[0.555555555555556	5.253968254	9]	[0.555555555555556	5.666666667	9]
A11	[0.555555555555556	5.063492063	9]	[0.555555555555556	5.531746032	9]
A12	[0.555555555555556	5.30952381	9]	[0.555555555555556	5.73015873	9]
A13	[0.555555555555556	5.619047619	9]	[0.555555555555556	5.761904762	9]

A14	[0.555555555555556 5.468253968 9]	[0.555555555555556 5.888888889 9]
A15	[0.555555555555556 5.547619048 9]	[0.555555555555556 6.015873016 9]
A16	[0.555555555555556 4.992063492 9]	[0.555555555555556 5.563492063 9]
A17	[0.555555555555556 5.253968254 9]	[0.555555555555556 5.666666667 9]
A18	[0.555555555555556 5.206349206 9]	[0.555555555555556 5.603174603 9]
A19	[0.555555555555556 5.063492063 9]	[0.555555555555556 5.73015873 9]
A20	[0.555555555555556 5.30952381 9]	[0.555555555555556 5.761904762 9]
A21	[0.555555555555556 5.650793651 9]	[0.555555555555556 5.888888889 9]
A22	[0.333333333333333 3.905895692 7]	[0.333333333333333 4.297052154 7]
A23	[0.555555555555556 4.992063492 9]	[0.555555555555556 5.753968254 9]
A24	[0.555555555555556 5.206349206 9]	[0.555555555555556 5.563492063 9]
A25	[0.555555555555556 5.317460317 9]	[0.555555555555556 5.666666667 9]
A26	[0.555555555555556 5.063492063 9]	[0.555555555555556 5.73015873 9]
A27	[0.555555555555556 5.30952381 9]	[0.555555555555556 5.761904762 9]
A28	[0.555555555555556 5.650793651 9]	[0.555555555555556 5.888888889 9]
A29	[0.555555555555556 5.468253968 9]	[0.555555555555556 5.873015873 9]
A30	[0.555555555555556 5.325396825 9]	[0.555555555555556 6.015873016 9]
A31	[0.555555555555556 4.992063492 9]	[0.555555555555556 5.563492063 9]
A32	[0.555555555555556 5.253968254 9]	[0.555555555555556 5.666666667 9]
A33	[0.555555555555556 5.063492063 9]	[0.555555555555556 5.531746032 9]
A34	[0.555555555555556 5.30952381 9]	[0.555555555555556 5.73015873 9]
A35	[0.555555555555556 5.619047619 9]	[0.555555555555556 5.761904762 9]
A36	[0.555555555555556 5.468253968 9]	[0.555555555555556 5.888888889 9]
A37	[0.555555555555556 5.547619048 9]	[0.555555555555556 6.015873016 9]
A38	[0.555555555555556 4.992063492 9]	[0.555555555555556 5.563492063 9]
A39	[0.555555555555556 5.253968254 9]	[0.555555555555556 5.666666667 9]
A40	[0.555555555555556 5.206349206 9]	[0.555555555555556 5.603174603 9]
A41	[0.555555555555556 5.063492063 9]	[0.555555555555556 5.73015873 9]
A42	[0.555555555555556 5.30952381 9]	[0.555555555555556 5.761904762 9]
A43	[0.555555555555556 5.650793651 9]	[0.555555555555556 5.888888889 9]

A44	[0.555555555555556 5.468253968 9]	[0.555555555555556 6.015873016 9]

MATLAB processes a combination of the results from Table 4.18 and Table 4.19 using Equation 3.15 to produce the Closeness Coefficient values shown in Table 4.20.

The CCi value, which represents the order in which 196 decision-makers ranked the multiple possibilities from best to worst, is a ratio scale rating. The results show that A44 (Satisfaction Level) is the most preferred sub-criteria because it has the highest CCi score. A5 (Competence) has the lowest CCi score of all the sub-criteria, making it the least preferred one.

Table 4.20 Closeness Coefficient of Each Sub-Criteria

Rank in Descending Order	Sub-Criteria	CCi
1	**A44**	1
2	**A36**	0.875969
3	**A42**	0.860465
4	**A38**	0.798450
5	**A43**	0.782946
6	**A29**	0.751938
7	**A41**	0.751938
8	**A2**	0.744186
9	**A35**	0.728682
10	**A24**	0.720930
11	**A40**	0.720930
12	**A26**	0.705426
13	**A31**	0.689922
14	**A37**	0.689922
15	**A32**	0.674419
16	**A14**	0.658915
17	**A33**	0.658915
18	**A34**	0.643411
19	**A13**	0.627907
20	**A30**	0.612403
21	**A15**	0.596899
22	**A4**	0.558140
23	**A10**	0.558140
24	**A1**	0.542636

25	**A18**	0.527132
26	**A17**	0.480620
27	**A39**	0.465116
28	**A9**	0.434109
29	**A19**	0.418605
30	**A25**	0.395349
31	**A28**	0.364341
32	**A7**	0.341085
33	**A3**	0.325581
34	**A23**	0.325581
35	**A12**	0.317829
36	**A16**	0.317829
37	**A27**	0.310078
38	**A11**	0.255814
39	**A6**	0.248062
40	**A8**	0.209302
41	**A20**	0.209302
42	**A21**	0.093023
43	**A22**	0.069767
44	**A5**	0

4.3 Discussion of Results

This study used a framework that combined three approaches, PCA, SERVQUAL, and Fuzzy TOPSIS to evaluate student satisfaction with information technology support services at Durban University of Technology. Overall, students were satisfied with the information technology support services offered. The SERVQUAL dimensions with the highest rankings were tangibility, reliability, assurance, empathy, and responsiveness. Fuzzy TOPSIS identified the "sub-criteria," meaning overall satisfaction with the services, as the top choice. The study's findings provided clear insights into the satisfaction levels of students with information technology technical support services and offered suggestions for improvement. Moreover, several studies (Al-Sofi 2021; Avsheniuk et al. 2021; Said 2021) on student satisfaction and service quality have been conducted, however they differ in methodology, focus and findings. For instance, Al-Sofi (2021) study was focused on student satisfaction with e-learning during the pandemic. Therefore, the students Satisfaction Index model was modified to investigate student satisfaction with the e-learning process during the pandemic (Al-Sofi 2021).

In addition, critical factors influencing student satisfaction, such as course instructors' facilities and services, technical support, and course content design were identified. Content analysis of graphical reports regarding university facilities and services was performed. Quantitative research design was employed with a questionnaire translated into Arabic and developed with Google Forms. Data was analyzed using SPSS with descriptive statistics, t-tests, ANOVA, Pearson's correlation coefficient, and multiple regression analysis. Students expressed high levels of satisfaction with e-learning and the technological services provided via WhatsApp and email. University facilities and services (training sessions, academic and administrative services, assistance with technology, and study guidelines and rules) improved student satisfaction with e-learning. The unanticipated and quick transition to online learning did not negatively impact student satisfaction. Avsheniuk *et al.* (2021) investigated student satisfaction with the overall online learning experience, including the effectiveness of online English for specific purposes (ESP) courses, learning materials, teacher performance, online testing and information technology support services.

Quantitative approach with descriptive statistics and JASP software was employed in the study. Students enrolled in ESP online courses at three faculties of Taras Shevchenko National University of Kyiv were surveyed. The results of the study indicated that students were generally satisfied with the online learning experience, including information technology support services. However, some challenges related to internet connectivity, lack of face-to-face interaction, and teachers' limited experience with online teaching were identified. Said (2021) concentrated on a broader study on student satisfaction with online learning during the COVID-19 lockdown, including information technology support services. Quantitative surveys with students and interviews with a select group of professors was conducted. Students were given surveys to complete on students satisfaction with the university's distance education portal, including IT support services. Professors were interviewed on their experiences with online teaching and student support. Students reported satisfaction with the ease of use and material accessibility of the portal. Few students found it easy to contact information technology support for portal issues. Half of the interviewed professors reported that the quality and reliability of internet connections were a challenge for online courses. Lack of one-on-one and face-to-face information technology support was a concern for some students.

Overall, while each study contributed valuable insights into service quality and satisfaction, however, the extant study stands out for its comprehensive methodology, relevance to a specific context, and clear findings. The unique mix of methods, focused on WhatsApp support, and the application of Fuzzy TOPSIS ranking offered a richer understanding of student preferences and areas for improvement, ultimately contributing to better information technology services for students across higher education. This combination provides valuable insights into student satisfaction with

information technology support services, contributing to improving service quality for students in higher education.

4.4 Summary

Before presenting the study's findings, this chapter presented the data gathered using the research instrument and examined the respondents' score patterns. To rank the sub-criteria in this multi-criterion decision-making problem, it discussed the validity and reliability of these results before applying the data to the Fuzzy TOPSIS approach developed using the MATLAB software. According to the ranking produced by the survey, Satisfaction Level is the best sub-criteria that has been chosen by the university students. The study's conclusions, major limitations, discussion of its contributions, and suggestions for additional research are presented in the chapter that follows.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the research study along with a description of how the study's aims and objectives were achieved. The significance, implications and shortcomings of the study are discussed. It also explains how the outcomes might influence and benefit society. Furthermore, recommendations for further research is presented and finally, this chapter concludes the study.

5.1 Study Summary

The study's aim was to evaluate students' level of satisfaction with information technology technical support services in higher education institutes. To achieve the goal of the study, as shown in Table 5.1, three research objectives were gathered. The need for this investigation was outlined in the problem statement. Chapter two examined the literature to evaluate the use of the SERVQUAL framework and the Fuzzy TOPSIS method in evaluating the satisfaction level of higher education students with information technology technical support services. The three primary concepts that form the theoretical foundation of this study were mentioned viz., student satisfaction, SERVQUAL model and Fuzzy TOPSIS method. The empirical studies for each were explained and the theoretical and empirical gaps were identified. Finally, the inclusion and exclusion criteria using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) technique was explained.

The theoretical framework and research methodology were established out in Chapter 3. Firstly, Principal Component Analysis was discussed. The SERVQUAL framework was yet another framework that was presented. The survey was conducted at the Durban University of Technology and assessed the degree of student satisfaction with the information technology technical support services they received. The survey questionnaire was the main research tool employed. SPSS software was used to collect and analyze the data. Additionally, as indicated in Table 5.1 the Fuzzy TOPSIS approach was employed to examine students' preferences among the 44 sub-criteria. Chapter 3 included a small example of using Fuzzy TOPSIS method to rank the 44 sub-criteria in order of "most preferred" to "least preferred" as indicated by two decision makers. This example involved using the 8 mathematical steps of Fuzzy TOPSIS.

Chapter Four included the statistical analysis of the survey questions. Both descriptive and inferential statistics were used in the data analysis. The Fuzzy TOPSIS results as implemented on MATLAB R2023a were provided in Section 4.2. The results show that Satisfaction Level is the preferred sub-criteria. Competence was the least preferred one. Finally, Chapter Five summarizes the results and demonstrate how each research objective of the study was accomplished.

The alignment of the research's aims and objectives, as well as how each research objective relates to the theoretical framework, data collection techniques, and data analysis, is shown in Table 5.1.

Table 5.1 Alignment of the Research

Aim: To evaluate students' level of satisfaction with Information Technology technical support services in higher education institutes			
Research Objectives	**Theoretical Framework**	**Data Collection Methods / Data Sources**	**Data Analysis / Results**
RO1: To identify suitable factors associated with Information Technology technical support services for higher education students by conducting a systematic literature review.	PRISMA	Chapter Two: Literature Review	Chapter Two: Presented in Table 2.1.
RO2: To develop a questionnaire to measure student satisfaction level with Information Technology technical support services.	PCA	Chapter Three: Information Technology support service factors Chapter Three: Survey Questionnaire	Chapter Three: Presented in Table 3.3 Chapter Four: Survey Results Presented in Table 4.4
RO3: To evaluate student Information Technology technical support services at higher education institutions.	Chapter Three: Decision Theory (Fuzzy TOPSIS method)	Chapter Four: Fuzzy TOPSIS method	Chapter Four: MATLAB 2023a; Fuzzy TOPSIS Results

5.2 Study Conclusions

This dissertation has conclusively demonstrated the crucial role of Information Technology (IT) technical support in enhancing student satisfaction within higher education institutions. Acknowledging IT support as a necessity rather than an option, the study aimed to identify and rank key success factors in the implementation of IT technical support services. Utilizing a novel framework combining Principal Component Analysis (PCA), Service Quality (SERVQUAL), and Fuzzy TOPSIS, the research analyzed 81 key success factors derived from 100 scholarly articles, leading to the identification of 25 primary components.

The SERVQUAL analysis, focusing on dimensions such as tangibility, reliability, assurance, empathy, and responsiveness, was pivotal in developing a questionnaire that effectively measured student perceptions of service quality. This instrument was deployed in a South African higher education institution, targeting students who interacted with the IT support team through WhatsApp. The collected data, processed through SERVQUAL, revealed an overall satisfaction level of 60 percent, indicating that the IT support services were generally well-received by the students.

The Fuzzy TOPSIS rankings further reinforced these findings, positioning overall satisfaction with support services at the highest rank. The convergence of SERVQUAL and Fuzzy TOPSIS outcomes suggests that the IT technical support services at Durban University of Technology adequately meet student needs and are valued by the student body. This research underscores the IT support team's compliance with quality service standards, though it also highlights opportunities for further enhancement through increased proactivity.

Significantly, this study offers valuable insights into the factors that can critically influence student satisfaction in higher education institutions. These factors are instrumental for management in assessing the success of IT technical support services and can serve as a benchmark for other institutions aiming to elevate the quality of their IT support services. By focusing on areas that demand continuous attention and improvement, higher education institutions can ensure high levels of student satisfaction, thereby securing future success and a competitive edge in the realm of technical support and student services.

5.3 Contributions and Implications of Study

The study contributes to the academic understanding of the factors that influence the quality and effectiveness of information technology technical support services in higher education. It provides a comprehensive overview of the existing literature in this area, synthesizing knowledge and identifying key concepts and variables. The findings can serve as a valuable resource for higher education institutions, helping them better understand the factors that are relevant to their information technology support services. This can inform their strategies and policies for improving these services. Institutions can use the identified factors to assess and enhance their information technology technical support services, potentially leading to improved student satisfaction, retention, and academic success. The systematic literature review may reveal gaps in the existing research, highlighting areas where further studies or research are needed. This can guide future research efforts in the field of information technology support services in higher education.

Developing a questionnaire to measure student satisfaction based on identified factors contributes to the development of a practical tool that can be used by higher education institutions to assess and monitor the quality of their information technology technical support services. Using factor analysis to rank and weight these factors adds a quantitative dimension to the study, providing a systematic and data-driven approach to evaluating the importance of each factor. The questionnaire can be a valuable tool for institutions to assess the satisfaction of their students with information technology support services. It allows for ongoing quality assessment and continuous improvement efforts. It enables institutions to benchmark their performance against peers and identify areas where improvements are required.

Another contribution of this study is by adopting the TOPSIS decision-making method, which contributes to the methodological diversity in the evaluation of information technology technical support services. It provides a structured and quantitative approach for decision-making and ranking sub-criteria. The use of TOPSIS can potentially lead to more efficient and effective decision-making processes for higher education institutions regarding their information technology support services. The TOPSIS method can help institutions make informed decisions when it comes to resource allocation, prioritizing improvements, and assessing the overall quality of their information technology support services. It can lead to the optimal allocation of resources, potentially resulting in cost savings and better service delivery.

5.4 Limitations of Study

Although the study had met its goals and objectives, it had limitations. This research was limited to Durban University of Technology students who had contacted the IT support call center via WhatsApp.

5.5 Future Research

Recommendations for future research based on the highlighted limitations should focus on conducting the study with a larger and more diverse sample that includes Durban University of Technology students, and possibly students from other universities of technology to increase the representativeness of the findings. In addition, conducting surveys through multiple channels (not just WhatsApp) could help reach a more representative sample, as some students might prefer other communication methods. Supplementing the quantitative survey data with qualitative research methods such as interviews or focus groups can provide deeper insights into the reasons behind students' perceptions and experiences with IT technical support, allowing for a more comprehensive understanding of the issues at hand.

REFERENCES

Abdul, D. and Wenqi, J. 2022. Evaluating appropriate communication technology for smart grid by using a comprehensive decision-making approach fuzzy TOPSIS. *Soft Computing*, 26 (17): 8521–8536.

Abdullah, F. 2006a. The development of HEdPERF: A new measuring instrument of service quality for the higher education sector. *Journal of International Journal of Consumer Studies*, 30 (6): 569–581.

Abdullah, F. 2006b. Measuring service quality in higher education: HEdPERF versus SERVPERF. *Journal of Marketing Intelligence and Planning*, 24 (1): 31–47.

Abdullah, F. 2006c. Measuring service quality in higher education: Three instruments compared. *International Journal of Research & Method in Education*, 29 (1): 71–89.

Aboubakr, R. M. and Bayoumy, H. M. M. 2022. Evaluating educational service quality among dentistry and nursing students with the SERVQUAL model: A cross-sectional study. *Journal of Taibah University Medical Sciences*, 17 (4): 648–657.

Adam, A. I. A. 2019. Service quality measurement in higher education: The case of Sudan university of science and technology. *Journal of Total Quality Management*, 16 (2): 1–14.

Afthanorhan, A., Awang, Z., Rashid, N., Foziah, H. and Ghazali, P. 2019. Assessing the effects of service quality in customer satisfaction. *Journal of Management Science Letters*, 9 (1): 13-24.

Ahmad, A. H. E. and Kawtharani, A. M. 2021. Service quality and students' satisfaction in private Lebanese higher education institutions: The case of X university. *Journal of higher education policy and leadership studies*, 2 (3): 100–118.

Ahmadi, H., Gholamzadeh, M., Shahmoradi, L., Nilashi, M. and Rashvand, P. 2018. Diseases diagnosis using fuzzy logic methods: A systematic and meta-analysis review. *Journal of Computer Methods and Programs in Biomedicine*, 161: 145–172.

Al-Juda, M. Q. B. 2017. Distance learning students' evaluation of E-learning system in University of Tabuk, Saudi Arabia. *Journal of Education and Learning*, 6 (4): 324-335.

Al-Sofi, B. B. M. A. 2021. Student Satisfaction with E-learning Using Blackboard LMS during the Covid-19 Circumstances: Realities, Expectations, and Future Prospects. *Pegem Journal of Education and Instruction*, 11 (4): 265–281.

Aldridge, S. and Rowley, J. 1998. Measuring customer satisfaction in higher education. *Journal of Quality Assurance in Education*, 6 (4): 197-204.

Alduraywish, Y., Patsavellas, J. and Salonitis, K. 2021. Critical success factors for improving learning management systems diffusion in KSA HEIs: An ISM approach. *Education and Information Technologies*, 27: 1105-1131.

Ali, S. R. O., Shariff, N. A. M., Said, N. S. M. and Mat, K. A. 2020. The effects of service quality dimensions on students' satisfaction: Hedperf model adoption. *Jurnal Intelek*, 15 (1): 69–76.

Alsabawy, A. Y., Cater-Steel, A. and Soar, J. 2016. Determinants of perceived usefulness of e-learning systems. *Computers in Human Behavior*, 64: 843–858.

Alshahrani, H. M., Alotaibi, S. S., Ansari, T. J., Asiri, M. M., Agrawal, A., Khan, R. A., Mohsen, H. and Hilal, A. M. 2022. Analysis and Ranking of IT Risk Factors Using Fuzzy TOPSIS-Based Approach. *Journal of Applied Sciences*, 12 (12): 1-14.

Alshammari, S. H. 2020. The influence of technical support perceived self-efficacy, and instructional design on students' use of learning management systems. *Turkish Online Journal of Distance Education*, 21 (3): 112–141.

Alzahrani, L. and Seth, K. P. 2021. Factors influencing students' satisfaction with continuous use of learning management systems during the COVID-19 pandemic: an empirical study. *Education and Information Technologies*, 26: 6787–6805.

Amoozegar, A., Daud, S. M., Mahmud, R. and Jalil, H. A. 2017. Exploring learner to institutional factors and learner characteristics as a success factor in distance learning. *International Journal of Innovation and Research in Educational Sciences*, 4 (6): 647–656.

Amponsah, S. and Agyekum, B. 2021. Service quality satisfaction: perceptions of Ghanaian higher education students learning at a distance. *UnisaRxiv*, 8 (1): 1–12.

Annamdevula, S. and Bellamkonda, R. S. 2016. Effect of student perceived service quality on student satisfaction, loyalty and motivation in Indian universities:Development of HiEduQual. *Journal of Modelling in Management*, 11 (2): 488-517.

Ansari, K. A., Farooqi, F. A., Khan, S. Q. and Alhareky, M. 2021. Perception on online teaching and learning among health sciences students in higher education institutions during the COVID-19 lockdown – ways to improve teaching and learning in Saudi colleges and universities. *F1000Research*, 10 (177): 1-16.

Ariyanto, E., Aima, M. H. and Sari, A. N. M. 2020. Analysis of the effect of service quality dimensions on student satisfaction in master of management of Mercu Buana University. *IOSR Journal of business and Management*, 22 (6): 05–13.

Arora, P. and Narula, S. 2018. Linkages between service quality, customer satisfaction, and customer loyalty: A Literature review. *IUP Journal of Marketing Management*, 17 (4): 30–53.

Asaduzzaman, Moyazzem, H. and Mahabubur, R. 2013. Service Quality and student satisfaction. A case study on private universities in Bangladesh. *International Journal of Economics, Finance and Management Sciences*, 1 (3): 128–135.

Asefi, F., Delaram, M. and Deris, F. 2017. Gap between the Expectations and Perceptions of Students Regarding the Educational Services Offered in a School of Nursing and Midwifery. *Journal of Clinical and Diagnostic Research*, 11 (4): 01– 04.

Athiyaman, A. 1997. Linking student satisfaction and service quality perceptions: the case of university education. *European Journal of Marketing*, 31 (7): 528–540.

Avsheniuk, N., Seminikhyna, N., Svyrydiuk, T. and Lutsenko, O. 2021. ESP Students' Satisfaction with Online Learning during the COVID-19 Pandemic in Ukraine. *Arab World English Journal Special Issue on Covid*, 19: 222-234.

Awang, N., Samy, G. A. L. N. and Hassan, N. H. 2022. Prioritizing Cybersecurity Management Guidelines using Analytical Hierarchy Process (AHP) Decision Technique. *Open International Journal of Informatics*, 10 (1): 1–10.

Awasthi, A., Chauhan, S. S., Omrani, H. and Panahi, A. 2011. Application of fuzzy TOPSIS method for ranking of maintenance strategies: a case study. *Journal of Quality in Maintenance Engineering*, 61 (3): 637-646.

Azam, A. 2018. Service quality dimensions and students' satisfaction: A study of Saudi Arabian private higher education institutions. *European Online Journal of Natural and Social Sciences*, 7 (2): 275–284.

Azaman, N. A., Bidin, J., Sharif, N. and Akil, K. A. K. 2023. Analysing Influential Factors in University Selection Using Fuzzy TOPSIS *Journal of Computing Research and Innovation*, 8 (2): 45-54.

Aziz, A. and Alluhaidan, A. S. 2022. Are we good enough? A measurement for Information Technology Service Quality (ITSQ) in higher education institutions in Saudi Arabia. *PLoS ONE*, 17 (11): 1-14.

Balwinder, S. and Prabhakar, T. V. 2012. A Simplified Description of Fuzzy TOPSIS. *ArXiv*, abs/1205.5098.

Banahene, S., Kraa, J. J. and Kasu, P. A. 2018. Impact of HEdPERF on students' satisfaction and academic performance in Ghanaian universities; mediating role of attitude towards learning. *Open Journal of Social Sciences*, 6 (5): 96–119.

Bank, W. 2010. *Financing Higher Education in Africa. Directions in Development ; human development* Available: http://hdl.handle.net/10986/2448 (Accessed 18 July 2022).

Barkhuizen, N., Mogwere, P. and Schutte, N. 2014. Talent Management, work engagement and service quality orientation of support staff in a higher education institution. *Mediterranean Journal of Social Sciences*, 5 (4): 69–77.

Bennington, L. and Cummane, J. 1998. Measuring service quality: A hybrid methodology. *Total Quality Management*, 9 (6): 395-405.

Berkley, B. J. and Gupta, A. 1994. Improving service quality with information technology. *International Journal of Information Management*, 14 (2): 109–121.

Blau, G., Snell, C. and Goldberg, D. 2021. Reinforcing the importance of maintaining internship support for college student engagement and anticipated employment. *Journal of Education and Learning*, 10 (1): 1-6.

Boshoff, C. and Plessis, P. J. D. 2009. *Services marketing: A contemporary approach*. illustrated ed. Cape Town: Juta and Company Ltd.

Boulding, K. D., Kalbra, A., Staeling, R. and Zeithaml, V. A. 1993. A dynamic process model of service quality: from expectations to behavioral intentions. *Journal of Marketing Research*, 30 (2): 7–27.

Brady, M. K. and Cronin, J. J. 2001. Some New Thoughts on Conceptualizing Perceived Service Quality: A Hierarchical Approach. *Journal of Marketing*, 65 (3): 34–49.

Brochado, A. 2009. Comparing alternative instruments to measure service quality in higher education. *Quality Assurance in Education*, 17 (2): 174–190.

Broderick, A. J. and Vachirapornpuk, S. 2002. Service quality in internet banking: the importance of customer role. *Marketing Intelligence & Planning*, 20 (6): 327–335.

Brogowicz, A. A., Delene, L. M. and Lyth, D. M. 1990. A Synthesised Service Quality Model with Managerial Implications. *International Journal of Service Industry Management*, 1 (1): 27-45.

Brooks, R. 2005. Measuring University Quality. *Review of Higher Education*, 29 (1): 1–21.

Brunson, K. W. 2010. Examining the Need for Customized Satisfaction Survey Instruments for Measuring Brand Loyalty for Higher Educational Institutions. *Liberty University School of Business Journal*, 8 (1): 1–22.

Bucarey, C. J., Duque, A. A., P`erez, S. M., Gallardo, L. A., Moscoso, M. M. and Vargas, E. C. 2021. Student's Satisfaction of the Quality of Online Learning in Higher Education: An Empirical Study. *Sustainability*, 13 (21): 1–14.

Carney, R. 1994. Building an Image symposium for the marketing of higher education. In: Proceedings of. 1994. New Orleans, Lousiana: American Marketing Association,

Carr, C. L. 2007. The FAIRSERV model: consumer reactions to services based on a multidimensional evaluation of service fairness. *Decision Sciences*, 38 (1): 107–130.

Chatterjee, A., Ghosh, G. and Bandyopadhyay, S. 2009. Assessing students' rating in highereducation: A SERVQUAL approach. *Total Quality Management and Business Excellence*, 20 (10): 1095-1109.

Creswell, J. W. and Creswell, J. D. 2018. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed. Thousand Oaks, CA: Sage publications, Inc.:

Cronin, J. J. and Taylor, S. A. 1992. Measuring service quality: A re-examination and extension. *Journal of Marketing*, 56 (3): 55–68.

Cronin, J. J. and Taylor, S. A. 1994. SERVPERF Vs SERVQUAL: Reconciling performance-based and perception minus expectations measurement of service quality. *Journal of Marketing*, 58 (1): 125–131.

Dabholkar, P. A. 1996. Consumer evaluations of new technology-based self-service options: an investigation of alternative models of service quality. *International Journal of Research in Marketing*, 13 (1): 29–51.

Dinh, T. H. V., Do, T. L. H., Nguyen, T., Pham, T. K. and Tran, H. N. 2021. Factors Influencing the Students' Perceptions of the Quality of Education Services at Hue University in Vietnam. *International Journal of Educational Sciences*, 32 (1-3): 1–11.

Doan, T. T. T. 2021. The effect of service quality on student loyalty and student satisfaction: an empirical study of universities in Vietnam. *Journal of Asian Finance, Economics and Business* 8(8): 251-258.

Entwistle, N. and Tait, H. 1990. Approaches to learning, evaluations of teaching, and preferences for contrasting academic environments. *Higher Education*, 19: 169–194.

Firdous, S. and Farooqi, R. 2019. Service Quality To E-Service Quality: A Paradigm Shift. In: Proceedings of. Bangkok, Thailand, March 5-7 2019. 1656–1666.

Floyd, D. L. and Casey-Powell, D. 2004. New Roles for Student Support Services in Distance Learning. *New Directions for Community Colleges*, 2004 (128): 55–64.

Foerderer, M., Hoffman, S., Schneider, N. and Prichard, J. R. 2021. Predicting levels of student satisfaction during COVID-19. *EduCause Review,* 2021: 1-14. Available: https://er.educause.edu/articles/2021/4/predicting-levels-of-student-satisfaction-during-covid-19 (Accessed 4 November 2022).

Fuchs, K. and Fangpong, K. 2021. Using the SERVQUAL framework to examine the service quality in higher education in Thailand. *Education Quarterly Reviews*, 4 (2): 363-370.

Gibson, J. L., Ivancevich, J. M. and Konopaske, R. 2006. *Organizations Behavior, Structure, Processes Avenue of the Americas*. 14, illustrated ed. New York, NY, 10020: McGraw-Hill Education.

Gliner, J. A., Morgan, G. A. and Leech, N. L. 2017. *Research Methods in Applied Settings : An Integrated Approach to Design and Analysis*. Third ed. New York, NY: Routledge:

Goetsch, D. L. and Davis, S. B. 2000. *Quality Management Introducing to Total Quality Management for Production, Processing, and Services*. 3rd ed. Prentice-Hall Inc.

Gopalakrishnan, S. and Ganeshkumar, P. 2013. Systematic reviews and meta-analysis: understanding the best evidence in primary healthcare. *Journal of family medicine and primary care*, 2 (1): 9–14.

Green, P. 2014. Measuring service quality in higher education: A South African Case Study. *Journal of International Education Research*, 10 (2): 131–142.

Grönroos, C. 1984. A service quality model and its marketing implications. *European Journal of Marketing*, 18 (4): 36–44.

Grönroos, C. 1988. Service quality: The six criteria of good perceived service. *Review of Business*, 9 (3): 10–13.

H.B.R. 2019. *6 Reasons Why Higher Education Needs to Be Disrupted* Cambridge,MA.: Available: https://hbr.org/2019/11/6-reasons-why-higher-education-needs-to-be-disrupted (Accessed 6 July 2022).

Hajdari, S. 2019. Measuring service quality in higher education using SERVQUAL model: evidence from an Albanian public faculty. *International Journal of Economics, Commerce, and Management*, 7 (8): 119–128.

Hall, C. K. 2010. *The role of student support services in encouraging student involvement and its impact on student perceptions and academic experiences*. Clemson University.

Hampton, G. M. 1993. Gap analysis of college student satisfaction as a measure of professional service quality. *Journal of Professional Services Marketing*, 9 (1): 115–128.

Han, H. and Trimi, S. 2018. A fuzzy TOPSIS method for performance evaluation of reverse logistics in social commerce platforms. *Expert Systems with Applications*, 103: 133–145.

Hanci, F. and Cebeci, E. 2019. Determination of morphological variability of different pisum genotypes using principal component analysis. *Legume Research-An International Journal*, 42 (2): 162–167.

Hassan, S., Shamsudin, M. F., Hasim, M. S., Mustapha, I., Buang, R. R. and Wahab, M. I. A. 2020. Empirical study on student satisfaction as mediator between servcie qulaity and student loyalty in TVET HLIs. *Journal of Critical Reviews* 7(8): 122-126.

Haywood-Farmer, J. 1988. A conceptual model of service quality. *International Journal of Operations & Production Management*, 1988 (8): 19–29.

Ho, S. K. and Wearn, K. 1996. A higher education TQM excellence model: HETQMEX. *Quality Assurance in Education*, 4 (2): 35-42.

Hoque, U. S., Akhter, N., Absar, N., Khandaker, M. U. and Al-Mamun, A. 2023. Assessing Service Quality Using SERVQUAL Model: An Empirical Study on Some Private Universities in Bangladesh. *Trends in Higher Education*, 2 (1): 255-269.

Hossain, M. I., Polas, M. R. H., Rahman, M. M., Islam, T. and Jamadar, Y. 2020. An Exploration of COVID-19 Pandemic and its Consequences on FMCG Industry in Bangladesh. *Journal of Management Info*, 7 (3): 145–155.

Huliatunisa, Y., Suhardan, D., Rasyid, S. and Sabban, I. 2022. Evaluation of the quality of education services. In: Proceedings of *Advances in Social Science, Education, and Humanities Research*. 2022. Atlantis Press, 320–326.

Hung, L. N. Q. 2021. Enhancing learners' satisfaction to improve retention in online classes: current practices at a center of foreign languages in Vietnam. *European Journal of Open Education and E-learning Studies*, 6 (2): 109-120.

Hutton, B., Catala-Lopez, F. and Moher, D. 2016. The PRISMA statement extension for systematic re-views incorporating network meta-analysis: PRISMA-NMA. *Medicina Clinica (Barc)*, 147 (6): 262–266.

Hwang, C. L. and Yoon, K. 1981. *Multiple attribute decision making: Methods and applications*. Berlin, Heidelberg, New York: Springer.

Ibrahim, M. Z., Rahman, M. N. and Yasin, R. M. 2012. Assessing students' perceptions of service quality in technical educational and vocational training (TEVT) institution in Malaysia. *Procedia Social and Behavioral Sciences*, 2012 (56): 272–283.

Ilias, A., Hasan, H. F. A., Rahman, R. A. and Yasoa, M. R. 2008. Student Satisfaction and Service Quality: Demographic Any Differences in Demographic Factors? *International Business Research*, 1 (4): 131–143.

Islam, S. and Himel, S. H. 2018. Services Quality and Students' Satisfaction: A Study on the Public Higher Education Institutions (HEIs) of Bangladesh. *Journal of Business*, 39 (2): 135-149.

Jamal, N. M., Khalif, K. K. and Mohamad, M. S. 2021. Implementing the reliability of data information in multi-criteria decision making process based on fuzzy TOPSIS and fuzzy entropy. *Journal of Physics: Conference Series*, 1988 (1): 1-15.

Jolliffe, I. T. and Cadima, J. 2016. Principal component analysis: a review and recent developments. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 374 (2016): 1-16.

Kajenthiran, K. and Karunanithy, M. 2015. Service quality and student satisfaction: a case of study of private external higher education institutions in Jaffna, Sri Lanka. *Journal of Business Studies*, 1 (2): 46–64.

Kandeepan, V., Vivek, R. and Seevaratnam, T. 2019. Impact of Organizational Citizenship Behaviour on Service Quality in Banking Sector, Vavuniya District. *Management*, 7 (2): 1-13.

Kang, G. and James, J. 2004. Service Quality Dimension: An Examination of Gronroo's Service Quality Model. *Managing Service Quality*, 14 (4): 266–277.

Kaufmann, A. and Gupta, M. M. 1991. *Introduction to Fuzzy Arithmetic: Theory and Applications*. illustrated, reprint ed. Van Nostrand Reinhold Company.

Kent, R. A. 2007. *Marketing Research: Approaches, Methods and Applications in Europe*. Thomson Learning.

Klir, G. J. and Yuan, B. 1995. *Fuzzy sets and fuzzy logic: Theory and applications*. Pearson College Div.

Kobero, W. and Swallehe, O. 2022. The effects of service quality on customer satisfaction in higher learning institutions in Tanzania. *Open Journal of Business and Management*, 10 (3): 1373–1391.

Kristensen, K., Martensen, A., Gronholdt, L. and Elkildsen, J. 2000. Measuring Student Oriented Quality in Higher Education: Application of the ECSI methodology. *Sinergie - Rapporti di ricerca*, 9 (18): 371–383.

Kumar, M., Kee, F. T. and Charles, V. 2010. Comparative evaluation of critical factors in delivering service quality of banks An application of dominance analysis in modified SERVQUAL model. *International Journal of Quality and Reliability Management*, 27 (3): 351-377.

Kumtepe, E. G., Toprak, E., Ozturk, A., Buyukkose, G. T., Kilinc, H. and Menderis, I. A. 2018. Support Services in Open and Distance Education: An Integrated Model of Open Universities. In: Proceedings of. May 2018. 114–123.

Lee, M. X. and Lee, Y. C. 2021. A Hybrid Fuzzy Decision Model for Evaluating MEMS and IC Integration Technologies. *Micromachines*, 12 (3): 1–13.

Lee, S. J., Srinivasan, S., Trail, T., Lewis, D. and Lopez, S. 2011. Examining the relationship among student perception of support, course satisfaction, and learning outcomes in online learning. *The Internet and Higher Education*, 14 (3): 158–163.

Lehtinen, U. and Lehtinen, J. R. 1982. *Service Quality: A Study of Quality Dimensions*. Service Management Institute.

Leonnard, L. 2018. The performance of SERVQUAL to measure service quality in private university. *Journal on Efficiency and Responsibility in Education and Science*, 11 (1): 16-21.

Mai, L. 2005. A Comparative Study between UK and US: The Student Satisfaction in Higher Education and its Influential Factors. *Journal of Marketing Management*, 21 (7-8): 859–878.

Malik, M. E., Danish, R. Q. and Usman, A. 2010. The Impact of Service Quality on Students' Satisfaction in Higher Education Institutes of Punjab. *Journal of Management Research*, 2 (2): 1–11.

Malkawi, E., Bawaneh, A. K. and Bawa`aneh, M. S. 2021. Campus Off, Education On: UAEU Students' Satisfaction and Attitudes Towards E-Learning and Virtual Classes During COVID-19 Pandemic *Contemporary Educational Technology*, 13 (1): 1-14.

Martilla, J. A. and James, J. C. 1977. Importance-performance analysis. *The Journal of Marketing*, 14 (1): 77–79.

Mattah, P. A. D., Kwarteng, A. J. and Mensah, J. 2018. Indicators of service quality and satisfaction among graduating students of a higher education institution (HEI) in Ghana. *Higher Education Evaluation and Development*, 12 (1): 36–52.

Mayisela, T., Govender, S. C. and Hodgkinson-William, C. A. 2022. *Open learning as a means of advancing social justice: Case in post-school education and training in South Africa Cape Town*. South Africa: African Minds.

McGivern, Y. 2006. *The Practice of Market Research: An Introduction*. Financial Times Prentice Hall.

Moher, D., Liberati, A., Tetzlaff, J. and Altman, D. G. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, 6 (7): 1–6.

Moher, D., Liberati, A., Tetzlaff, J. and Altman, D. G. 2010. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*, 151 (4): 264–269.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M. and Stewart, L. A. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews*, 4 (1): 1–9.

Molina, M. G., Gavilán-Martín, D. and Álvarez-Herrero, J. F. 2021. Education for Sustainable Development: The Impact of the Values in Mobile Phone Addiction. *Sustainability* 13 (3): 1-17.

Muhammad, N., J., K. S., Baloch, Q. B. and Ali, F. 2018. Service quality is the road ahead for student satisfaction. *Review of Public Administration and Management*, 6 (2): 1–6.

Mulyono, H., Hadian, A., Purba, N. and Pramono, R. 2020. Effect of service quality toward student satisfaction and loyalty in higher education. *Journal of Asian Finance, Economics, and Business*, 7 (10): 929–938.

Musaad, O. A. S., Zhuo, Z., Siyal, Z. A., Shaikh, G. M., Shah, S. A. A., Solangi, Y. A. and Musaad, O. A. O. 2020. An integrated multi-criteria decision support framework for the selection of suppliers in small and medium enterprises based on green innovation ability. *Processes*, 8 (4): 1-23.

Muthamia, S. M. 2016. An assessment of university service quality and its effects on student satisfaction: A case of United States International University. Doctoral dissertation, United States International University-Africa.

Nanaj, X. 2006. Measuring service quality in higher education: evidence from an Albanian private university. MA in Marketing, University of Sheffield.

Navarro-Marzo, M., Pedraja-Iglesias, M. and Rivera-Torres, M. 2005. Measuring customer satisfaction in summer courses. *Quality Assurance in Education*, 13 (1): 53–65.

Nguyen, A. N., Tran, N. H., Tran-Chi, V. L. and Tran, C. V. 2020. Lao students' perceptions towards quality education service in a selected higher education institution in Central Vietnam. *International Journal of Educational Sciences*, 28 (1-3): 63-71.

O'Neill, M. A. and Palmer, A. 2004. Importance-performance analysis: a useful tool for directing continuous quality improvement in higher education. *Quality Assurance in Education*, 12 (1): 39–52.

Onogo, M. O. 2019. *Examining perceptions of service quality of student services and satisfaction among international students at Universities in Indiana and Michigan*. Andrews University.

Owino, E., Kibera, F., Munyoki, J. and Wainaina, G. 2014. Service Quality in Kenyan Universities: Dimensionality and Contextual Analysis. *European Journal of Business and Management*, 6 (11): 180-194.

Owlia, M. S. and Aspinwall, E. M. 1996. Quality in Higher Education. A survey. *Total Quality Management*, 7 (2): 161–171.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C. and Mulrow, C. D. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372 (71): 1–9.

Panhwar, A. H., Ansari, S. and Shah, A. A. 2017. Post-positivism: An effective paradigm for social and educational research. *International Research Journal of Arts & Humanities (IRJAH)*, 45 (45): 253-260.

Parasuraman, A., Valarie, A., Zeithaml, V. A. and Leonard, L. B. 1985. A Conceptual Model of Service Quality and Its Implications for Future Research. *The Journal of Marketing*, 49 (4): 41–50.

Parasuraman, A., Zeithaml, V. A. and Berry, L. L. 1988. SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing*, 64 (1): 12–40.

Parasuraman, A., Zeithaml, V. A. and Berry, L. L. 1990. *Delivering quality service: Balancing customer perceptions and expectations*. illustrated ed. Simon and Schuster.

Parasuraman, A., Zeithaml, V. A. and Berry, L. L. 1991. *Delivering Quality Service in Balancing Customer Perceptions and Expectations*. New York, USA: The Free Press.

Park, E. J. and Kim, H. B. 2013. The role of social experience in undergraduates' career perceptions through internships. *Journal of Hospitality, Leisure, Sport and Tourism Education*, 12 (1): 70–78.

Pedrycz, W. 1994. Why triangular membership functions? *Fuzzy Sets and Systems*, 64 (1): 21–30.

Pereda, M., Airey, D. and Bennett, M. 2007. Service Quality in Higher Education: The Experience of Overseas Students. *Journal of Hospitality, Leisure*, 6 (2): 55–67.

Petrov, Y., Istomin, E., Stepanov, S., Sidorenko, A. and Vagizov, M. 2020. Development of a conceptual GIS model to support management decision making. In: Proceedings of *IOP Conference Series: Earth and Environmental Science*. 2020.

Prasad, U. D. and Madhavi, S. 2014. Service quality measurement in paper distribution: a comparative study of perceived and expected service with an application of analytical hierarchy process model. *The International Journal of Management*, 3 (2): 21–30.

Price, I., Matzdorf, F., Smith, L. and Agahi, H. 2003. The impact of facilities on student choice of university. *Facilities*, 21 (10): 212–222.

Puriwat, W. and Tripopsakul, S. 2021. The impact of e-learning quality on student satisfaction and continuance usage intentions during COVID19. *International Journal of Information and Education Technology*, 11 (8): 368–374.

Pursan, G., Adeliyi, T. T. and Joseph, S. 2023. Information Technology Technical Support Success Factors in Higher Education: Principal Component Analysis. *International Journal of Advanced Computer Science and Applications*, 14 (6): 270–282.

Quin, H., Prybutok, V. R. and Zhao, Q. 2010. Perceived service quality in fast-food restaurants: empirical evidence from China. *International Journal of Quality & Reliability Management*, 27 (4): 424-437.

Raaper, R. 2019. Students as consumers? A counter perspective from student assessment as a disciplinary technology. *Teaching in Higher Education*, 24 (1): 1–16.

Raja, S. and Rajan, A. J. 2022. A Decision-Making Model for Selection of the Suitable FDM Machine Using Fuzzy TOPSIS. *Hindawi Mathematical Problems in Engineering*, 2022 (2022): 1-15.

Raju, M. S. and Bhaskar, N. U. 2017. Service quality in higher education: a review and conceptual model. *International Journal of Science Technology and Management*, 6 (2): 891–901.

Ralph, W. 1991. *Help!: The Art of Computer Technical Support*. illustrated ed. Peachpit Press.

Ramphal, R. R. and Nicolaides, A. 2014. Service and quality and quality service: satisfying customers in the hospitality industry. *African Journal of Hospitality, Tourism and Leisure*, 3 (2): 1-18.

Ramsaran-Fowdar, R. R. 2007. Developing a service quality questionnaire for the hotel industry in Mauritius. *Journal of Vacation Marketing*, 13 (1): 19-27.

Raphael, C. and Mtebe, J. 2016. Instructor support services: An inevitable critical success factor in blended learning in higher education in Tanzania. *International Journal of Education and Development using ICT*, 12 (2).

Rashid, W. E. W. and Jusoff, H. K. 2009. Service quality in health care setting. *International Journal of Health Care Quality Assurance*, 22 (5): 471-482.

Roscoe, J. T. 1975. *Fundamental Research Statistics for the Behavioral Sciences*. Holt, Rinehart and Winston.

Rotar, O. 2022. Online student support: a framework for embedding support interventions into the online learning cycle. *Research and Practice in Technology Enhance Learning*, 17 (2): 1-23.

Rovai, A. P. and Downey, J. R. 2010. Why Some Distance Education Programs Fail While Others Succeed in a Global Environment. *The Internet and Higher Education*, 13 (3): 141–147.

Rust, R. T. and Oliver, R. L. 1994. Service quality: insights and managerial implications from the frontier. *Service Quality: New Directions in Theory and Practice*, 1994: 1-19.

Ryan, A. B. 2006. Post-positivist approaches to research. In: Researching and writing your thesis: A guide for postgraduate students. In. 12-26. Available: https://mural.maynoothuniversity.ie/874/ (Accessed 07 December 2023).

Sadiq Sohail, M. and Shaikh, N. M. 2004. Quest for excellence in business education: a study of student impressions of service quality. *The International Journal of Educational Management*, 18 (1): 58–65.

Said, G. R. E. 2021. How did the COVID-19 pandemic affect higher education learning experience? An empirical investigation of learners' academic performance at a university in a developing country. *Advances in Human-Computer Interaction*, 2021: 1-10.

Saleem, S. S., Moosa, K., Imam, A. and Khan, R. A. 2017. Service quality and student satisfaction: the moderating role of university culture, reputation and price in education sector of Pakistan. *Iranian Journal of Management Studies*, 10 (1): 237-258.

Saliba, K. and Zoran, A. G. 2018. Measuring higher education services using the SERVQUAL model. *Journal of Universal Excellence*, 4: 160–179.

Sánchez, R., Hueros, A. and Ordaz, M. 2013. E-learning and the University of Huelva: A study of WebCT and the technological acceptance model. *Campus-Wide Information Systems*, 30 (2): 135–160.

Sangeeta, S., Banwet, D. K. and Karunes, S. 2004. A SERVQUAL and QFD approach to total quality education: A student perspective. *International Journal of Productivity and Performance Management*, 53 (2): 143–166.

Sangeeta, S., Banwet, D. K. and Karunes, S. 2010. Quality framework in education through application of interpretive structural modeling: an administrative staff perspective in the Indian context. *The TQM Journal*, 22 (1): 56–71.

Santos, J. 2003. E-service quality: a model of virtual service quality dimensions. *Managing Service Quality:An International Journal*, 13 (3): 233–246.

Saravanan, R. and Rao, K. S. P. 2007. Measurement of Service Quality from the Customer's Perspective – An Empirical Study. *Total Quality Management and Business Excellence*, 18 (4): 435-449.

Schijns, J. M. C. 2021. Measuring service quality at an online university: using PLS-SEM with archival data. *Tertiary Education and Management*, 27: 161–185.

Schwantz, G. D. 1996. *Service quality in higher education: expectations and perceptions of traditional and non-traditional students*. Texas Tech University.

Sekaran, U. 2000. *Research methods for business: a skill-building approach*. John Wiley and Sons, Inc.

Senthilkumar, N. and Arulraj, A. 2010. SQM-HEI-determination of service quality measurement of higher education in India. *Journal of Modelling in Management*, 6 (1): 60–78.

Shah, F. T. 2013. Service quality and customer service satisfaction in higher education in Pakistan. *Journal of Quality and Technology Management*, 9 (9): 73–89.

Shahijan, M. K., Rezaei, S. and Guptan, V. P. 2018. Marketing public and private higher education institutions: A total experiential model of international student's satisfaction, performance and continues intention. *Journal of International Review on Public and Nonprofit Marketing*, 15: 205–234.

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P. and Stewart, L. A. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ*, 349 (2015): 1–25.

Sharma, S. 2008. Principal component analysis (PCA) to rank countries on their readiness for e-tail. *Journal of Retail and Leisure Property*, 7 (2): 87-94.

Shikulo, L. and Lekhetho, M. 2020. Exploring student support services of a distance learning center at a Namibian university. *Journal of Cogent Social Sciences*, 6 (1): 1-15.

Shrestha, N. 2021. Factor Analysis as a Tool for Survey Analysis. *American Journal of Applied Mathematics and Statistics*, 9 (1): 4-11.

Sibai, M. T., Bay, B. J. and Rosa, R. D. 2021. Service Quality and Student Satisfaction Using ServQual Model: A Study of a Private Medical College in Saudi Arabia *International Education Studies*, 14 (6): 51-58.

Simmons, L. D. 2013. Factors of Persistence for African American Men in a Student Support Organisation. *The Journal of Negro Education*, 82 (1): 62–74.

Singh, R. and Khanduja, D. 2010. SERVQUAL and Model of Service Quality Gaps: A Framework for Determining and Prioritizing Critical Factors from Faculty Perspective in Higher Education. *International Journal of Engineering Science and Technology*, 2 (7): 3297–3304.

Smith, R. 2007. An Overview of Research on Student Support: Helping Students to Achieve or Achieving Institutional Targets. *Teaching in Higher Education*, 12 (5-6): 683–695.

Spreng, R. A. and Mackoy, R. D. 1996. An empirical examination of a model of perceived service quality and satisfaction. *Journal of Retailing*, 72 (2): 201– 214.

Stewart, B. L., Goodson, C. E., Miertschin, S. L., Norwood, M. L. and Ezell, S. 2013. Online Student Support Services: A Case Based on Quality Frameworks. *Journal of Online Learning and Teaching*, 9 (2): 290–303.

Stewart, L. A., Clarke, M., Rovers, M., Riley, R. D., Simmonds, M., Stewart, G. and Tierney, J. F. 2015. Preferred reporting items for a systematic review and meta-analysis of individual participant data: the PRISMA-IPD statement. *Jama*, 313 (16): 1657–1665.

STHDA. 2019. *Principal component methods in R: A Practical Guide*. Available: http://www.sthda.com/english/articles/31-principal-component-methods-in-r-practical-guide/112-pca-principal-component-analysis-essentials#pca-data-format (Accessed 27 June 2022).

Stribbell, H. and Duangekanong, S. 2022. Satisfaction as a key antecedent for word of mouth and an essential mediator for service quality and brand trust in international education. *Humanities and Social Science Communications* 9(1): 1-11.

Sultan, P. and Wong, H. 2010. Performance-based service quality model: an empirical study on Japanese universities. *Quality Assurance in Education*, 18 (2): 126–143.

Swecker, H. K., Fifolt, M. and Searby, L. 2013. Academic advising and first-generation college students: A quantitative study on student retention. *NACADA Journal*, 33 (1): 46-53.

Teas, K. R. 1993. Expectations, performance evaluation, and consumers' perceptions of quality. *Journal of Marketing*, 57 (4): 18–34.

Teeroovengadum, V., Kamalanabhan, T. J. and Seebaluck, A. K. 2016. Measuring service quality in higher education: Development of a hierarchical model (HESQUAL). *Quality Assurance in Education*, 24 (2): 244–258.

Thapa, M. 2022. Impact of service quality on student satisfaction: A case study of public sector higher secondary institution. *The Batuk*, 8 (1): 1–15.

Thompson, R. C., Joseph, S. and Adeliyi, T. T. 2022. A Systematic Literature Review and Meta-Analysis of Studies on Online Fake News Detection. *Information*, 13 (11): 527.

Tsinidou, M., Gerogiannis, V. and Fitsilis, P. 2010. Evaluation of the factors that determine quality in higher education: an empirical study. *Quality Assurance in Education*, 18 (3): 227-244.

Twum, F. O. and Peprah, W. K. 2020. The Impact of Service Quality on Students' Satisfaction. *International Journal of Academic Research in Business and Social Sciences*, 2020 (10): 169–181.

Union, E. 2017. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A renewed EU agenda for higher education*. Brussels, Belgium: European Commission.

Việt, V. V. 2021. The effect of service quality dimensions on student's satisfaction and loyalty. *ABAC Journal*, 41 (1): 81–99.

Voon, B. H. 2006. Linking a service-driven market orientation to service quality. *Managing Service Quality*, 16 (6): 595-619.

Wang, T. C., Thu Nguyen, T. T. and Phan, B. N. 2022. Analyzing higher education performance by entropy-TOPSIS method: A case study in VietNam private universities. *Measurement and Control*, 55 (5-6): 385-410.

Welman, C., Kruger, F. and Mitchell, B. 2005. *Research Methodology*. 3rd ed. Oxford University Press.

Westmaas, L., BA. and MSc. 2022. *Psychology, Communication, and the Canadian Workplace*. 1st ed. Fanshawe College Pressbooks.

Xu, X., Xie, J., Wang, H. and Lin, M. 2022. Online education satisfaction assessment based on cloud modeland fuzzy TOPSIS. *Applied Intelligence*, 52 (12): 13659-13674.

Xue, D., Zhao, Q. and Guo, X. 2008. TOPSIS Method for Evaluation Customer Service Satisfaction to Fast Food Industry. In: Proceedings of *In 2008 IEEE international conference on service operations and logistics, and informatics* 2008. 920-925.

Yahaya, W., Asante, J. and Alhassan, I. 2020. Institutional Service Quality and Students' Satisfaction: Perceptions from the University for Development Studies. *IOSR Journal of Business and Management*, 22 (7): 31–42.

Yousapronpaiboon, K. 2014. SERVQUAL: Measuring higher education service quality in Thailand. *Procedia Social and Behavioral Sciences*, 116: 1088-1095.

Zaleski, S. and Michalski, R. 2021. Success Factors in Sustainable Management of IT Service Projects: Exploratory Factor Analysis. *Sustainability*, 13 (8): 1-28.

Zhu, F. X., Wymer, W. and Chen, I. 2002. IT-based services and service quality in consumer banking. *International Journal of Service Industry Management*, 13 (1): 69–90.

ANNEXURE A: An Example Using FUZZY TOPSIS

Using a small sample of the data gathered via the survey questionnaire, this section tries to explain the sequential steps of the Fuzzy TOPSIS technique as stated in Section 3.3.4.2. The equations used in fuzzy TOPSIS are explained and applied in the little example that follows.

In this illustration, there are eleven options available for the two student decision makers to select from, including service response, service assurance, trustworthiness and loyalty, commitment, competence, reputation, technical support staff, communication material, communication method, location, and satisfaction level. Five factors—tangibility, reliability, responsiveness, assurance, and empathy—are used to evaluate the possibilities. Two members of the technical support team rated the criterion in linguistic terms in accordance with the required ratings. The detailed analysis that follows employs the Fuzzy TOPSIS method.

Step 1: Ratings for Criteria and Sub-Criteria Assigned by Decision Makers

The weights of the criteria and ratings of the sub-criteria in relation to these criteria must be determined first. The 5-point Likert scale was chosen by the researcher due to its usefulness and accessibility in collecting and operationalizing complicated phenomena with ease, enabling numerical values to aid in statistical testing and analysis.

As shown in Tables 3.6 and 3.7, respectively, the importance weights of the ratings of the sub-criteria and the criteria are taken into consideration as linguistic variables in this study and are described as fuzzy triples ranging from 1 to 9.

Table 3.6 Linguistic Terms for Sub-Criteria Ratings

SUB-CRITERIA	
A1	Service Response
A2	Commitment
A3	Service Assurance
A4	Trustworthy and Loyalty
A5	Competence
A6	Reputation
A7	Technical Support Staff
A8	Communication Material
A9	Method of Communication
A10	Location
A11	Satisfaction Level

Linguistic Term	Membership Function
Strongly Disagree (SD)	**(1,1,3)**
Disagree (D)	**(1,3,5)**
Slightly Agree (SA)	**(3,5,7)**
Agree (A)	**(5,7,9)**
Strongly Agree (STA)	**(7,9,9)**

CRITERIA	
C1	Responsiveness
C2	Assurance
C3	Reliability
C4	Empathy
C5	Tangibility
C6	Satisfaction Level

Table 3.7 Linguistic Terms for Criteria Ratings

Linguistic Term	Membership Function
Very Poor (VP)	**(1,1,3)**
Poor (P)	**(1,3,5)**
Fair (F)	**(3,5,7)**
Good (G)	**(5,7,9)**
Very Good (VG)	**(7,9,9)**

The linguistic terms listed in Table 3.8 are rated by the two decision makers to assess the eleven sub-criteria against the five criteria.

SUB-CRITERIA RATINGS BY DECISION MAKERS

Table 3.8 Linguistic Language Rankings for Sub-Criteria

	C1		C2	C3	C4	C5					C6
Sub-Criteria	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**
DM1	A	SA	A	SA	STA	STA	STA	STA	STA	STA	STA
DM2	STA	SA	A	A	SA	A	A	A	A	A	A

Two members of the technical support team rated the criterion in linguistic terms as represented in Table 3.9.

CRITERIA WEIGHTINGS BY TECHNICAL SUPPORT EXPERTS

Table 3.9 Linguistic Language Technical Support Expert Weightings of Criteria

Criteria	C1		C2	C3	C4	C5					C6
DM1	VG	VG	G	VG	VG	VG	G	VG	VG	VG	VG
DM2	G	G	G	VG	VG	VG	G	VG	VG	VG	VG

The sub-criteria rankings matrix displayed in Table 3.10 is created using the respective fuzzy triple representations for the data gathered, represented, and described in Tables 3.8 and 3.6.

SUB-CRITERIA RATINGS BY DECISION MAKERS

Table 3.10 Fuzzy Triple Representations for Sub-Criteria Rankings Matrix

Criteria	C1		C2	C3	C4	C5					C6
Sub-Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
DM1	5,7,9	3,5,7	5,7,9	3,5,7	7,9,9	7,9,9	7,9,9	7,9,9	7,9,9	7,9,9	7,9,9
DM2	7,9,9	3,5,7	5,7,9	5,7,9	3,5,7	5,7,9	5,7,9	5,7,9	5,7,9	5,7,9	5,7,9

The expert weightings matrix displayed in Table 3.11 is created using the corresponding fuzzy triple representations for the data gathered, represented, and defined in Tables 3.9 and 3.7.

CRITERIA WEIGHTINGS BY TECHNICAL SUPPORT EXPERTS

Table 3.11 Fuzzy Triple Representations for Expert Weightings Matrix

Criteria	C1		C2	C3	C4	C5					C6
DM1	7,9,9	7,9,9	5,7,9	7,9,9	7,9,9	7,9,9	5,7,9	7,9,9	7,9,9	7,9,9	7,9,9
DM2	5,7,9	5,7,9	5,7,9	7,9,9	7,9,9	7,9,9	5,7,9	7,9,9	7,9,9	7,9,9	7,9,9

Step 2: Compute Aggregate Fuzzy Ratings for the Criteria and the Sub-Criteria

Equation 3.3 in Section 3.3.4.2. is used to determine the data's aggregated relevance, which is reflected in the aggregated sub-criteria rankings matrix displayed in Table 3.12.

Table 3.12 Aggregated Sub-Criteria Rankings Matrix

Criteria	C1		C2	C3	C4	C5					C6
Sub-Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
	5,8,9	3,5,7	5,7,9	3,6,9	3,7,9	5,8,9	5,8,9	5,8,9	5,8,9	5,8,9	5,8,9

Equation 3.3 in Section 3.3.4.2. is used to compute the aggregated relevance of the data for the criteria weightings matrix, which is reflected in the aggregate criteria weightings matrix displayed in Table 3.13.

Table 3.13 Aggregated Criteria Weightings Matrix

Criteria Weights	C1		C2	C3	C4	C5					C6
	5,8,9	5,8,9	5,7,9	7,9,9	7,9,9	7,9,9	5,7,9	7,9,9	7,9,9	7,9,9	7,9,9

Step 3: Normalize the Fuzzy Decision Matrix

To make the multiple criteria scales comparable, the aggregated triangular fuzzy values shown in Table 3.12 must be normalized using a linear scale transformation. Equation 3.8 from Section 3.3.4.2. is used to perform this on the triangular fuzzy numbers in Table 3.12, producing the normalized App ranks fuzzy matrix shown in Table 3.14.

Table 3.14 Normalized Sub-Criteria Rankings Fuzzy Matrix

Criteria	C1		C2	C3	C4	C5					C6
Sub-Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
	0,55555 0,88888 1,00000	0,42857 0,71428 1,00000	0,55555 0,77777 1,00000	0,33333 0,66666 1,00000	0,33333 0.77777 1,00000	0.55555 0,88888 1,00000	0.55555 0,88888 1,00000	0.55555 0,88888 1,00000	0.55555 0,88888 1,00000	0.55555 0,88888 1,00000	0.55555 0,88888 1,00000

Step 4: Compute the Weighted Normalized Matrix

The weighted fuzzy values for each criterion must be considered when calculating the triangular fuzzy ratings of the Sub-Criteria in this stage of the Fuzzy TOPSIS approach. As a result, Equation 3.10 in Section 3.3.4.2. was used to compute the weighted normalized Sub-Criteria rankings fuzzy matrix shown in Table 3.15 using the aggregated criteria weightings matrix shown in Table 3.11 and the normalized Sub-Criteria rankings fuzzy matrix shown in Table 3.14.

Table 3.15 Weighted Normalized Sub-Criteria Rankings Fuzzy Matrix

Criteria	C1		C2	C3	C4	C5					C6
Sub-Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
	2,77775 7,11104 9.00000	1,28571 3,5714 7,00000	2,77775 5,44439 9,00000	0,99999 3,99996 9,00000	0.99999 5,44439 9,00000	2.77775 7,11104 9,00000	2.77775 7,11104 9,00000	2.77775 7,11104 9,00000	2.77775 7,11104 9,00000	2.77775 7,11104 9,00000	2.77775 7,11104 9,00000

Step 5: Compute the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS)

According to the TOPSIS approach, the option that is the furthest away from the Fuzzy Positive Ideal Solution (FPIS) is called the Fuzzy Negative Ideal Solution (FNIS), which is made up of the poorest performance values. These sub-criteria represent the best options and are calculated using Equations 3.12 and 3.11 from Section 3.3.4.2. The results are shown in Table 3.16.

Table 3.16 Fuzzy FNIS and FPIS values

FNIS (A-)	FPIS (A+)
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000
0.99999	9,00000

Step 6: Compute the Distance of Each Sub-Criteria from FPIS and FNIS

Equations 3.13 and 3.14 in Section 3.3.4.2. on the Weighted Normalized Sub-Criteria Rankings Fuzzy Matrix presented in Table 3.15 and utilizing the FNIS and FPIS values shown in Table 3.16 are used to calculate the separation between each weighted sub-criteria and the FNIS and FPIS. Table 3.17 is an illustration of the outcome.

Table 3.17 Distance of Each Weighted Sub-Criteria from the FNIS and FPIS Values

Criteria	C1		C2	C3	C4	C5					C6
	d^-										
Sub-Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
	5.90213	3.77243	5.38248	5.16397	5.28371	5.90213	5.90213	5.90213	5.90213	5.90213	5.90213

Criteria	C1		C2	C3	C4	C5					C6
	d^+										
Sub-Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
	3.75431	5.56716	4.13758	5.44672	5.05445	3.75431	3.75431	3.75431	3.75431	3.75431	3.75431

Step 7: Compute the Closeness Coefficient (CCi) of Each Sub-Criteria.

The proximity coefficient simultaneously depicts the separations between the fuzzy positive and fuzzy negative ideal solutions. The proximity coefficient for each sub-criteria is computed using the formulas presented in Equation 3.15 and shown in Table 3.18.

Table 3.18 Closeness Coefficient of Each Sub-Criteria

Closeness Coefficient (CCi)											
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
d^-	5.90213	3.77243	5.38248	5.16397	5.28371	5.90213	5.90213	5.90213	5.90213	5.90213	5.90213
d^+	3.75431	5.56716	4.13758	5.44672	5.05445	3.75431	3.75431	3.75431	3.75431	3.75431	3.75431
	0.61121179	0.40391816	0.56538	0.4866762	0.511088	0.611212	0.611212	0.61121179	0.61121	0.61121	0.6112118
CCi	9.65644	9.33959	9.52006	10.61069	10.33816	9.65644	9.65644	9.65644	9.65644	9.65644	9.65644

Step 8: Rank the Sub-Criteria

The sub-criteria that is closest to the FPIS and farthest from the FNIS has the highest proximity coefficient, making it the best sub-criteria. As shown in Table 3.19, the sub-criteria are ranked as a result by placing them in descending order of their closeness coefficient values.

Table 3.19 Ranking of Sub-Criteria

SUB-CRITERIA	RANKING
A1	9th
A11	7th
A6	6th
A7	8th
A8	3rd

A9	5th
A10	4th
A3	10th
A5	2nd
A4	1st
A2	11th

Ranked in Descending Order:

SUB-CRITERIA	RANKING
A4	Trustworthy and Loyalty
A5	Competence
A8	Communication Material
A10	Location
A9	Method of Communication
A6	Reputation
A11	Satisfaction Level
A7	Technical support staff
A1	Service Response
A3	Service Assurance
A2	Commitment

ANNEXURE B: Ethics Clearance to Conduct the Study

DUT
DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

FACULTY OF ACCOUNTING & INFORMATICS

Faculty of Accounting & Informatics
Durban University of Technology
Faculty Research Office
Block D Ritson Campus
DURBAN, 4001

P O Box 1334, DURBAN, 4000
South Africa
Tel: (031) 373 6767
Fax: (031) 373 5593

www.dut.ac.za

27 July 2023

Student: Geeta Pursan
Student Number: 19652470
Degree: Master of ICT
Email: 19652470@dut4life.ac.za
Supervisor: Dr Timothy Adeliyi
Supervisor email:

Dear Mrs Pursan

Evaluating the Level of Satisfaction in Higher Education Students with Technical Support Services in multimodal teaching and learning environments Using TOPSIS Decision Method title of study

I am pleased to inform you that **PROVISIONAL APPROVAL** has been granted to your proposal subject to:

- Please provide a brief report of the pilot study or pretest for quantitative data collection tools.
- Obtaining and submitting the necessary gatekeeper permission/s to Faculty of Accounting and Informatics Research Ethics Committee (FAI-FREC).

PLEASE NOTE THAT THIS IS NOT A FINAL APPROVAL LETTER. KINDLY SUBMIT THE ABOVE-MENTIONED DOCUMENTS WITHIN THREE MONTHS TO THE FAI-FREC OFFICE. DATA COLLECTION CAN ONLY COMMENCE WHEN FAI-FREC ISSUES FULL APPROVAL

Approval has been granted for a period of **ONE YEAR**, before the expiry of which you are required to apply for annual recertification at least 3 months before the ethics approval for the study expires.

It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.

Yours Sincerely,

[redacted]

Dr. M. Rajkoomar
Faculty Research Committee Chairperson
Tel: +2731 373 5645
Email: mogier@dut.ac.za

ANNEXURE C: Permission to Conduct Study at DUT

Directorate for Research and Postgraduate Support
Durban University of Technology
Open House
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732946

1 August 2023

Mrs Geeta Pursan
c/o Department of Information Technology
Faculty of Accounting and Informatics
Durban University of Technology

Dear Mrs Pursan

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted **Gatekeeper Permission** for you to conduct your research "Evaluating the Level of Satisfaction in Higher Education Students with Technical Support Services in multimodal teaching and learning environments using TOPSIS Decision Method title study" at the Durban University of Technology. **Kindly note that this letter must be issued to the IREC for approval before you commence data collection**.

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

Upon completion of your research project, you are requested to share the summary of your key research findings.

Kind regards.
Yours sincerely

[redacted]

DR V GOVENDER
ACTING DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECTORATE

DUT
DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

FACULTY OF ACCOUNTING & INFORMATICS

Faculty of Accounting & Informatics
Durban University of Technology
Faculty Research Office
Block D Ritson Campus
DURBAN, 4001

P O Box 1334, DURBAN, 4000
South Africa
Tel: (031) 373 6767
Fax: (031) 373 5593

www.dut.ac.za

14 August 2023

Student: Geeta Pursan
Student Number: 19652470
Degree: Master of ICT
Email: 19652470@dut4life.ac.za
Supervisor: Dr Timothy Adeliyi

Dear Ms Pursan

Evaluating the Level of Satisfaction in Higher Education Students with Technical Support Services in multimodal teaching and learning environments Using TOPSIS Decision Method title of study

The FAI-Research Ethics Committee acknowledges receipt of your gatekeeper permission letter.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FAI-FREC.

Please note that any deviations from the approved proposal require the approval of the FAI-FREC before data can be collected.

It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.

Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-FREC office on completion of your study.

Yours Sincerely,

[redacted]

Dr. M. Rajkoomar
Faculty Research Committee Chairperson
Tel: +2731 373 6776
Email: mogier@dut.ac.za

ANNEXURE D: Survey Questionnaire Sent to all Students that had Contacted the WhatsApp Technical Support Team

FACULTY OF ACCOUNTING AND INFORMATICS, DURBAN UNIVERSITY OF TECHNOLOGY

EVALUATING THE LEVEL OF SATISFACTION IN HIGHER EDUCATION STUDENTS WITH TECHNICAL SUPPORT SERVICES IN MULTIMODAL TEACHING AND LEARNING ENVIRONMENTS USING FUZZY TOPSIS DECISION METHOD

Survey Questionnaire

Dear Student

Thank you for agreeing to participate in this research project that requires your response in terms of your satisfaction of the technical support services that are being provided to you.

Your IT technical support staff will be able to provide you with better IT technical support services with the help of the information you submit in this survey.

Kindly be advised that participation in this survey is voluntary and that responses will remain anonymous. Your responses cannot be linked to you because your information is not stored in the system.

You may contact the researcher by emailing geetap@dut.ac.za should you require any assistance and/or clarification. The questionnaire should take 20-30 minutes to complete.

Thanking you in advance for your participation.
Geeta Pursan

Section 1 of 2

FACULTY OF ACCOUNTING AND INFORMATICS, DURBAN UNIVERSITY OF TECHNOLOGY

EVALUATING THE LEVEL OF SATISFACTION IN HIGHER EDUCATION STUDENTS WITH TECHNICAL SUPPORT SERVICES IN MULTIMODAL TEACHING AND LEARNING ENVIRONMENTS USING FUZZY TOPSIS DECISION METHOD

Survey

In this survey, you are kindly required to answer all questions to the best of your knowledge.

Please provide an appropriate response to each sub-question by selecting the correct option that best describes the extent of your satisfaction in terms of the technical support services that are being provided to you.

PART ONE

Demographic Information

1. Age: *

Short answer text

2. Gender: *

- ○ Male
- ○ Female

3. Study Type: *

- ○ Full Time
- ○ Part Time

4. Study Level: *

- ○ First Year
- ○ Second Year
- ○ Third Year
- ○ Fourth Year

5. Department: *

Short answer text

Section 2 of 2

PART TWO

Please read each question carefully. Please answer each of the following questions by selecting the option that best describes your opinion.

1. Service Response *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Technical supp...	○	○	○	○	○
Students are al...	○	○	○	○	○
Technical supp...	○	○	○	○	○
Technical supp...	○	○	○	○	○
Technical supp...	○	○	○	○	○

2. Service Assurance *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Technical supp...	○	○	○	○	○
Staff are court...	○	○	○	○	○

Information is ...					
Technical supp...					
Technical supp...					

3. Trustworthiness and Loyalty *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Students impo...					
Staff show sin...					
Technical supp...					
Technical supp...					

4. Commitment *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Staff always un...					
Staff always av...					
Technical supp...					

Technical supp...					
Technical supp...					

5. Competence *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Employees tak...					
Employee act q...					
Employee is a...					
Staff go to gre...					
Staff have appr...					

6. Reputation *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Technical supp...					
Individual servi...					
Staff have stud...					

7. Technical Support Staff *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Timeliness of s...	○	○	○	○	○
Knowledge and...	○	○	○	○	○
Effectiveness o...	○	○	○	○	○
Effective use o...	○	○	○	○	○

8. Communication Material *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Information pr...	○	○	○	○	○
Documents pro...	○	○	○	○	○
Steps provided...	○	○	○	○	○

9. Method of Communication *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Tech staff are ...	○	○	○	○	○
The WhatsApp ...	○	○	○	○	○
WhatsApp serv...	○	○	○	○	○

10. Location *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
Remote techni...	○	○	○	○	○
Remote techni...	○	○	○	○	○
Remote techni...	○	○	○	○	○

11. Satisfaction Level *

	Strongly Disagr...	Disagree	Slightly Agree	Agree	Strongly Agree
I feel satisfied ...	○	○	○	○	○
I feel satisfied ...	○	○	○	○	○
Are you satisfie...	○	○	○	○	○
Overall, I am sa...	○	○	○	○	○

ANNEXURE E: Study Originality Report

Evaluating the Level of Satisfaction in Higher Education Students with Technical Support Services Provided Using FUZZY TOPSIS Decision Method

ORIGINALITY REPORT

14%	9%	13%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.researchgate.net Internet Source	1%
2	researchspace.ukzn.ac.za Internet Source	1%
3	Submitted to Tshwane University of Technology Student Paper	1%
4	Kesarie Singh, Nalindren Naicker, Mogiveny Rajkoomar. "Selection of Learning Apps to Promote Critical Thinking in Programming Students using Fuzzy TOPSIS", International Journal of Advanced Computer Science and Applications, 2021 Publication	1%
5	hdl.handle.net Internet Source	1%
6	eprints.staffs.ac.uk Internet Source	1%