UNIVERSITY of RWANDA

Design of an Information System for Assessing Service Quality (IS-ASQ) at the University of Rwanda, College of Science and Technology: Case of Selected Services

Submitted By

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A dissertation submitted in partial fulfilment of the requirement for the degree of

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Supervisors: Dr. Pierre BAKUNZIBAKE

Dr. Christine MUSANASE

August, 2024

DECLARATION

I declare that this project entitled, **"Design of an Information System for Assessing Service Quality (IS-ASQ) at the University of Rwanda, College of Science and Technology: Case of Selected Services"** is original and has never been submitted to any University or other Institution of Higher Learning Education. It is my research whereby other scholar's writings were cited as references. I thus declare this work is mine and was completed successfully under the supervision of Dr. Pierre BAKUNZIBAKE, and Dr. Christine MUSANASE.

Eric NDAYISHIMIYE

221031397

Signature: …… 

Date: 20/08/2022

Certificate

This is to certify that the project work entitled "DESIGN OF AN INFORMATION SYSTEM FOR ASSESSING SERVICE QUALITY (IS-ASQ) AT THE UNIVERSITY OF RWANDA, COLLEGE OF SCIENCE AND TECHNOLOGY: CASE OF SELECTED SERVICES" is a record of original work done by Eric NDAYISHIMIYE with Reg no: 221031397 in partial fulfillment of the requirement for the award masters of science in Information system option E-government in the College of Science and Technology, University of Rwanda during the academic year 2021-2024

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Eric NDAYISHIMIYE

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LIST OF SYMBOLS AND ACRONYMS

APIs	**:**	Application Programming Interfaces
AR	**:**	Action Research
CASS	**:**	College of Arts and Social Sciences
CAVM	**:**	College of Agriculture, Animal Sciences, and Veterinary Medicine
CBE	**:**	College of Business and Economics
CE	**:**	College of Education
CGIS	**:**	Centre for GIS and Remote Sensing
CMHS	**:**	College of Medicine and Health Sciences
CSI	**:**	Customer Satisfaction Index
CSS	**:**	Cascading Style Sheet
CSS	**:**	Customer Satisfaction Score
CST	**:**	College of Science and Technology
DevOps	**:**	Development Operations
DFD	**:**	Data Flow Diagram
DSR	**:**	Design Science Research
DSRM	**:**	Design Science Research Methodology
ERD	**:**	Entity Relationship Diagram
HCD	**:**	Human-Centered Design
HEC	**:**	Higher Education Council
HQ	**:**	Head Quarter
HTML	**:**	Hypertext Markup Language
ICT	**:**	Information and Communication Technology
IEBMIS	**:**	Integrated Educational Business Management Information System
IS	**:**	Information Systems
ISAE	**:**	Institute of Agriculture and Animal Husbandry

IS-ASQ	**:**	Information System for Assessing Service Quality
KHI	**:**	Kigali Health Institute
KIE	**:**	Kigali Institute of Education
KIST	**:**	Kigali Institute of Science and Technology
MySQL	**:**	My Structured Query Language
NUR	**:**	National University of Rwanda
OOAD	**:**	Object-Oriented Analysis and Design
PHP	**:**	Hypertext Preprocessor
RAD	**:**	Rapid Application Development
RESTful	**:**	Representational State Transfer
SDLC	**:**	System Development Life Cycle
SFB	**:**	School of Finance and Banking
SSADM	**:**	Structured Systems Analysis and Design Methods
TAM	**:**	Technology Acceptance Model
TCA	**:**	Thematic Content Analysis
UI	**:**	User Interface
UML	**:**	Unified Modeling Language
UP	**:**	Umutara Polytechnic
UR	:	University of Rwanda

ABSTRACT

This master's thesis presents the Design of the Information System for Assessing Service Quality (IS-ASQ) aimed at improving service delivery and customer satisfaction at the University of Rwanda, College of Science and Technology. The study identified the current challenges in service quality assessment and proposed a comprehensive system to address these issues. The IS-ASQ is designed with user-friendly interfaces, including various modules such as respondent categories, feedback mechanisms, service assessment interface, and service provider login and authentication interface. The research methodology included a detailed analysis of existing systems, user requirements gathering, and the application of design principles to develop an efficient system. The design encompasses system architecture, database design, and user interface design, ensuring the system's scalability, reliability, and usability.

The findings indicated that the IS-ASQ can significantly enhance the assessment process by providing real-time feedback, detailed reporting, and streamlined service evaluations. However, the study is limited to the design phase, and future work is needed to complete the development, testing, and implementation stages of the Systems Development Life Cycle (SDLC). The conclusion recommended the continuation of the implementation phase, to ensure its integration with other university systems, and continuous improvement based on user feedback and technological advancements.

Keywords: Service Quality, Information System, Customer Satisfaction, Systems Development Life Cycle (SDLC), and Feedback Mechanism.

CHAPTER 1. INTRODUCTION

The design of information systems for assessing the quality of service is a complex task that requires a thorough evaluation from various perspectives in extending knowledge in both paper-based services and online-based services also known as e-services. This research focused on designing an Information System for assessing the quality of service at the University of Rwanda, College of Science and Technology using the selected services, namely admission, and registration as e-services in the office of registrar and transcripts and "to whom it may concern" letter issuance as paper-based services in schools within the University of Rwanda, College of Science and Technology. The quality-of-service assessment serves as the backbone of service delivery evaluation which requires a deep understanding of key indicators and customer expectations. Service delivery assessments are used to implement changes to the service being provided or to compare alternative methods of service delivery so that there is an improvement in the quality of service for the customer (Alan & Samir, Research Research in Information Systems, 2010).

The assessment process included a meticulous selection of methodologies for data collection and processing such as surveys, interviews, and observations. Data analysis plays a pivotal role in generating concrete insights from collected data by highlighting areas for improvement and identifying existing gaps. Establishing a robust feedback system for assessing the quality of service delivered is vital for continuous enhancement, ensuring exceptional service delivery and fostering positive organizational changes that cater to customer needs and satisfaction (Dyah, M. Mujiya, Priska, & Nadia, 2016).

1.1. The Background of University of Rwanda (UR)

The University of Rwanda (UR) was established by Law No. 71/2013 dated 10/09/2013 which determined its mission, powers, organization and functioning structure. The University of Rwanda was officially established through the consolidation of the previous seven public higher learning institutions that were well-known in Rwanda and these institutions were the National University of Rwanda (NUR), Kigali Institute of Science and Technology (KIST), Kigali Institute of Education (KIE), Institute of Agriculture and Animal Husbandry (ISAE), Kigali Health Institute (KHI), School of Finance and Banking (SFB) and Umutara Polytechnic (UP) (HEC, 2024).

The establishment of the University of Rwanda (UR) emerged in the framework of creating a strategic response to enhancing the quality, efficiency and coordination of higher education in Rwanda. Like many countries, Rwanda recognized the fundamental role of education in driving socio-economic development. However, before establishing the University of Rwanda, the higher education landscape in Rwanda was comprised with multiple universities and institutions and each one was operating independently with varying focuses and specializations. This fragmented structure and presented different challenges mostly in terms of financial resource allocation, coordination, and quality assurance within the universities and institutions (FARQUHAR, 2017).

Consolidating these disparate entities into a single flagship institution addressed the existing challenges by centralizing resources, streamlining operations, and fostering greater collaboration among academic faculties and departments. By uniting under one university structure, Rwanda sought to improve the efficiency and effectiveness of its higher education system, thereby better positioning itself to meet the evolving needs of its society and economy. Moreover, the establishment of UR was driven by a desire to enhance the quality of higher education in Rwanda by merging diverse faculties and academic disciplines into a single University that could offer a wider range of programs, resources, and opportunities to students.

The academic programs were also standardized and accreditation processes across all constituent colleges and faculties within UR were envisioned to ensure consistency and quality assurance, thereby enhancing the reputation and recognition of Rwandan higher education institutions both domestically and internationally (Theophile & Etienne, 2020). The establishment of the University of Rwanda were aligned with Rwanda's broader development goals such as the human capital development, capacity building and the transition of the country from the agriculture-based economy to a knowledge-based economy.

Recognizing the prominence of research and innovation in driving socio-economic progress, the University of Rwanda was poised to prioritize research initiatives, interdisciplinary collaboration, and partnerships with industry and government. The promotion of the culture of innovation and entrepreneurship hence addressing the national development priorities and contributing to Rwanda's vision for sustainable growth and prosperity. The establishment of the University of Rwanda also reflected Rwanda's commitment to advancing higher education as a catalyst for socio-economic transformation through consolidation, coordination, and quality

enhancement while becoming a leading institution of higher learning in the region by empowering individuals, driving innovation and contributing to Rwanda's journey toward becoming a knowledge-driven economy country (Baidada, 2016).

Currently, the University of Rwanda (UR) is composed of six colleges distributed within the country with different missions on training higher learning students such as the College of Education (CE), College of Science and Technology (CST), College of Arts and Social Sciences (CASS), College of Business and Economics (CBE), College of Agriculture, Animal Sciences and Veterinary Medicine (CAVM) and College of Medicine and Health Sciences (CMHS) (HEC, 2024). The University of Rwanda dedicated its mission on providing high-quality education and fostering innovative teaching and research endeavors which aims in address the educational challenges and skills gaps at local, national, regional, and global levels (HEC, 2024). The six colleges host a total of 21 schools spread across 10 campuses nationwide. Each college is led by a principal, while schools are overseen by deans and campus management which is also under the purview of Campus Managers (UR, 2018).

1.2. College of Science and Technology (CST)

The College of Science and Technology is part of the University of Rwanda; whose formation was put in law on October 15th 2013. The College, also known as UR-CST has a central role to play in the social and economic development of the nation. This is much more in a view of the fact that Rwanda has chosen Science and Technology as vehicles for national development. In support of this, the College engages in capacity building relevant to this cause by spearheading scientific and technological innovation through robust and relevant research programs (GATARE, 2024).

Geographically, the College is located on 3 campuses mainly the Nyarugenge campus (HQ), Huye and Nyagatare. Right from its inception, the college setup a development action plan for the College focusing on 5 Priority Areas such as Investing in Academic Excellence, investing in better Student Support and Welfare, Investing in Staff Development, creating a Research based institution and Community Outreach (GATARE, 2024).

The UR-CST also hosts six centres such as African Centre of Excellence in Energy for Sustainable Development, African Centre of Excellence in Internet of Things, Centre of

Excellence in Biodiversity and Natural Resources Management, International Centre for Theoretical Phyisics (EAIFR), Centre for GIS and Remote Sensing (CGIS) and the Regional Centre of Excellence in Biomedical Engineering and eHealth (College of Science and Technology, 2024).

1.3. College Registrar's Office

The Registrar's Office at the University of Rwanda, College of Science and Technology has quite a good reputation with its student-centered objective strategic plan. It is an essential unit within the college that provides a variety of services and supports for prospective students. The support is structure in both the current students, alumni, schools and departments. The Registrar's Office is also known as the Keeper of the Students' Academic Record (University of Rwanda, College of Arts and Social Sciences(CASS), 2024). The Office of Registrar is designated for undertaking functions which principally turn around threefold areas namely Students' admission and registration, Timetabling and examinations management, Transcripts and other academic documents' issuance.

The office's job is to ensure integrity and accuracy in anything involved with academic history, facilitate students' application for admission, registration, make updates to student's record, evaluate transfer credit including for those studying abroad and provide services such as transcripts, degree certificates and enrollment verifications for scholarships. Also, the office provides reports to the College to assist in decision making and departmental course planning, enrollment information to student loan lenders for different purposes. Towards the conclusion of their time in college, students' records are audited by the registrar's office to ensure eligibility for graduation and to calculate honors. This underscores the pivotal role of the Office of the College Registrar, which serves as both the entry point and exit point for students. While students may perceive the office as the creator of academic policies, its primary function is to safeguard and uphold these policies, including academic regulations, and ensure their consistent application.

Table 1: The Office of Registrar's Functions and Related Tasks *(University of Rwanda, College of Arts and Social Sciences(CASS), 2024)*

Functions	Tasks
Coordinate admission and registration of students	- Participate in setting institutional admissions and registration-related policies - Participate in candidate selection - Follow up registration exercise - Communicate to prospective students, the admissions decisions promptly - Coordinate all application and admissions activities of the College, including distance education, continuing education, and all off-campus sites
Oversee the security of students' academic records	- Ensure that students' marks are safely kept - Avail effective mechanism to retrieve students' records when needed - Keep on updating institutional management on students' statistics
Management and Issuance of students' Academic documents	- Issuance of academic documents (Testimonials, Transcripts, Certificates) - Handling queries and complaints relating to academic documents - Endorse academic documents
Planning and monitoring of teaching and learning	- Oversee the annual academic calendar and propose possible changes where necessary - Ensure teaching and assessment timetable is respected - Participate in formulation of internal assessment policy

1.3.1. Selected Services in Registrar's Office

The Registrar's Office is responsible for three primary functions (Aletha RUZAMBA, 2024): student admission and registration, timetabling and examinations management and issuing transcripts and other academic documents. This research will focus on only two offered e-services by the College Registrar's Office namely admission and registration which are available within the University of Rwanda's Integrated Education Business Management Information System.

1.4. Departments and Schools

The College of Science and Technology is made of 5 schools distributed in different fields such as Architecture and Built Environment, Engineering, Mining Engineering and Applied Geology, Sciences and Information and Communication Technology. Schools are academic organs that have different responsibilities in ensuring the smooth running of administrative, academic and research activities within the college. It receives and approves Departmental reports, students' transcripts, to whom it may concern and the workload of each academic staff, manage research projects and deliberate student's marks at school level.

Table 2: Departments and Schools within the College of Science and Technology *(University of Rwanda, 2020)*

Schools	Departments
School of Information and Communication Technology-SoICT	• Department of Computer Engineering • Department of Information Technology • Department of Information System • Department of Computer Science
School of Architecture and Built Environment-SoABE	• Department of Construction Management • Department of Architecture • Department of Estate Management &Valuation • Department of Geography and Urban Planning

School of Sciences	• Department of Chemistry • Department of Biology • Department of Mathematics • Department of Mathematics and Statistics • Department of Physics
School of Mining and Geology	• Department of Geology • Department of Mining
School of Engineering	• Department of Civil, Environmental and Geomatics Engineering • Department of Mechanical Engineering • Department of Electrical -electronics & telecom Engineering

1.4.1. Selected Services from Schools and Departments.

This research focused on designing an information system for assessing those selected services by evaluating the effectiveness and efficiency of two selected paper-based services, issuance of to whom it may concern in the schools, and issuance of students' transcripts in departments. The design will investigate various aspects of these services including their accuracy, timeliness, accessibility, and overall user experience.

1.5. Background and Motivation

The design of an information system for assessing the service quality at the University of Rwanda, College of Science and Technology is very crucial in evaluating the quality-of-service delivery to the students as a means for reaching the students' satisfaction. It is important to note that the design of information system for assessing the service quality would be specifically tailored for feedback collection mechanism on service delivered and promises to improve on both the student’s satisfaction and the reputation of the institution. The design of an information

system for assessing the service quality will ensure the delivery of top-quality service by the dedicated and esteemed personnel of the institution.

This research focused only on admissions and registration services as the e-services in the Registrar's office and the issuance of transcripts and "to whom it may concern" letters which remain paper-based services delivered in the schools and the departments at the College of Science and Technology. The designed information system for assessing service quality will not only serve as a tool for service quality evaluation but would also act as a catalyst for continuous improvement within the College of Science and Technology.

The data obtained through this system would enable the College of Science and Technology to make data-driven decisions and formulate strategies to further enhance the quality of service delivered. Therefore, the design of this system will improve the service quality to the esteemed students and renowned University of Rwanda (UR), College of Science and Technology in providing a high service quality to all stakeholders.

1.6. Problem Statement

The University of Rwanda, College of Science and Technology has different Information Systems that help in strengthening academic culture and management such as academic records management, registration of students, admission of students, staff payroll, and financial management but it doesn't have an Information System to check on how good or bad the level of services delivered to its stakeholders are. The absence of a dedicated Information System for assessing service quality limits the college's ability to systematically gather and analyze stakeholders' feedback. This gap in evaluation mechanisms makes it challenging for the college to detect areas of improvement that affect its overall service standards. Therefore, need for a tailored Information System for assessing service quality. The system would gather valuable students' insights and enable informed decision-making, targeted service improvements, and an enhanced service experience. This research aims to design an Information System for admissions and registration-related services within the college's Registrar's Office and paper-based services such as issuing "to whom it may concern" letters and transcripts within the college's schools and departments, respectively.

1.7. Research Objectives and Questions

1.7.1. General Objective

This research aims to improve the quality of service delivery to stakeholders and feedback mechanisms within the selected services of the University of Rwanda, College of Science and Technology registrar's office, schools, and departments by presenting a system design for assessing service quality.

1.7.2. Specific Objectives

1. To understand the design of an information system for assessing service quality.
2. To identify the requirements of an information system for assessing service quality.
3. To design the information system for assessing the service quality of the selected services in the college's registrar's office, departments, and schools.

1.7.3. Research Questions

1) What are the functional and non-functional system requirements (design characteristics) needed to design IS-ASQ?
2) What design principles and methodology should be employed to create effective IS-ASQ?
3) What are the constraints for designing an IS-ASQ for collecting feedback in the University of Rwanda, College of Science and Technology?

1.8. Hypothesis

This work is built on the hypothesis that implementing the IS-ASQ system will improve service delivery at the University of Rwanda, College of Science and Technology.

1.9. Scope of the Study

There are multiple services for students and staff at the University of Rwanda, some of them are delivered online and others are still delivered using the traditional way as paper-based services. Examples of offered services include library, administration, finance, registration, admission, compilation of academic records, management and issuance of students' academic documents,

student welfare, teaching and learning, etc. Admission and registration are one of the services that are delivered online at the University of Rwanda, College of Science and Technology and the issuance of transcripts and to whom it may concern are also delivered using the traditional method as paper-based services. This research will design an information system for assessing the quality of service at the University of Rwanda by measuring the service quality level on admission and registration and the issuance of transcripts and to whom it may concern as online a paper-based services in enhancing the improvement of quality-of-service delivery at the University of Rwanda, College of Science and Technology.

1.10. Significance of the Study

This research will enhance the Service Quality at the University of Rwanda, College of Science and Technology by focusing on the design of IS-ASQ to improve service quality within the college's registrar's office, departments, and schools. The research aims to identify and define the system requirements for designing IS-ASQ to assess the service quality in the Registrar's Office and the schools. Through this endeavor, the study research will streamline the operations and elevate the overall quality of services provided to stakeholders.

1.11. Organization of the Research

This research is organized into six chapters which are also structured as follows, the first chapter gives an introduction that contains the project objectives, scope of the study, problem statement, background and motivation, hypothesis, significance of the study, and the organization of the study. The literature review is provided in the second chapter. The third chapter provides the research methodology, the fourth chapter provides the system design as-is, and the system design to be with the system requirements. The results of the newly designed system are presented in chapter five, and then comes chapter six with a conclusion, recommendations, and future work.

CHAPTER 2. LITERATURE REVIEW

2.1. Introduction

In the education sector, customers are classified into two categories students and staff. Those categories play a crucial role in the education domain and advancement of higher education. As education costs increase in higher learning education, students have started to view education as an investment in challenging it to create a framework that helps in meeting their needs. Poor service delivery can result from inefficient resource distribution and the damage of the institution's reputation. To prevent this, a system to assess service delivery and collect feedback from the customer is essential in higher education institutions, particularly the most frequently visited offices such as the college's registrar, departments, and schools in creating high-quality and standard service while attracting students and enhancing quality education in public and private institutions of higher education.

2.2. Related Literature

Table 3: Related Literature in designing information system for assessing service quality

Author	Title & Reference	Strength	Area of improvement
Martin Sykora, Suzanne Elayan, Ian R. Hodgkinson, Thomas W. Jackson, and Andrew West.	The power of emotions: Leveraging user-generated content for customer experience management. (Martin, Suzanne, Ian R., Thomas W., & Andrew, 2022)	Comprehensive analysis of customer experience management and emotion detection in digital contexts	Development of more advanced tools for real-time integration and causal inference

Aaron R. Lyon, and Cara C. Lewis	Designing Health Information Technologies for Uptake: Development and Implementation of Measurement Feedback Systems in Mental Health Service Delivery. (Aaron R. & Cara C., 344–349)	Provides a comprehensive review of digital measurement feedback systems, offering insights into their capabilities and characteristics.	Adding tracking elements may help providers personalize care, especially when patient outcomes are poor. Also, MFS might eventually aid real-time decision-making for each unique client based on available evidence.
Yudhishthira Sapru	Augmenting Public Service Delivery Through Online Feedback Systems. (Sapru, 2020)	Empower citizens to actively participate in shaping public services by sharing their experiences and suggestions.	Establish clear pathways for translating feedback into actionable steps. Involve relevant stakeholders in decision-making based on feedback insights.
Li-Chin Chen, Chi-Wen Chen, Yung-Ching Weng, Rung-	An information technology framework for strengthening	A robust framework for enhancing telehealthcare service	Requires further empirical validation and real-world testing

Ji Shang, Hui-Chu Yu, Yufang Chung, Feipei Lai	telehealthcare service delivery. (Li-Chin, et al., 2012)	delivery using information technology	to ensure effectiveness and scalability
Girish Kumar D, Suresh U, Kaushik CH, Naveed J, Giritej N	Automation System to Measure the Performance of Employee (Kumar D., Suresh U, Kaushik CH, Naveed J, & Giritej N, 2018)	The system makes the availability of feedback any time anywhere with ease of use and provides easy and secure storage with access restrictions.	The system could be improved by enhancing data security, optimizing performance, integrating with other college systems, improving the user interface, and incorporating advanced feedback analysis tools.
Shakeel Ahmad Dar	Faculty Feedback Management System (Dar, 2018)	Every time feedback is given, a counter is stored in the database which provides information about the number of students, counter is used to determine the average performance analysis.	Ensuring the feedback system provides constructive and actionable insights specifically tailored for the development of early career teachers.

2.3. Information System

An information system (IS) refers to a system that collects, processes, stores and disseminates information to support decision-making and control within an organization. It encompasses hardware, software, data, procedures, and people working together to collect, process, store, and distribute information for various organizational purposes (Marlon, Wil M., & Arthur H., 2005). This information system supports decision-making, coordination, control, analysis, and visualization within an organization. The people component includes users, managers, and IT professionals. Processes refer to the workflows and procedures that manage data and transform it into useful information. Technology encompasses the hardware, software, and network infrastructure that facilitate these activities (James A. & George M., 2011). An information system is comprised of two sub-systems such as technical sub-system and a social sub-system. The technical sub-system encompasses the technology and process components while the social sub-system encompasses the people and structure components (Watson, 2007). This research will focus on the design of the software (web-based systems, also known as web applications or online systems) as a component of the technical sub-system of IS-ASQ.

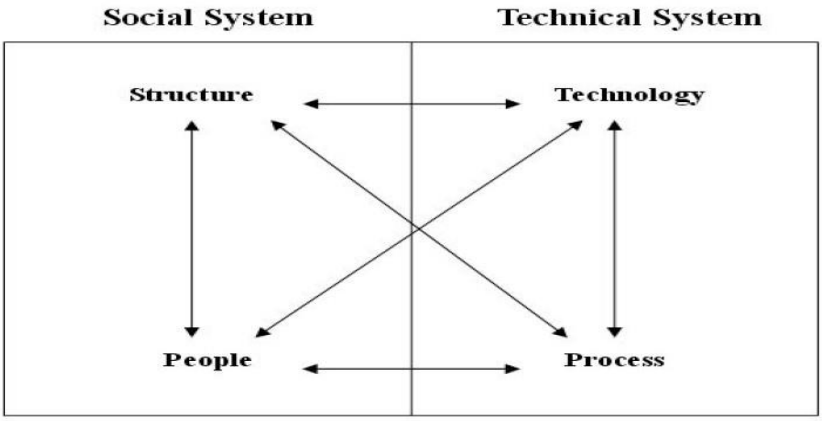

Figure 1: The four components of an information system (Watson, 2007).

Table 4: Two Sub-Systems of an Information System (Watson, 2007)

Social Sub-System	People	encompasses all those individuals who are directly involved with the system. These people include the managers who define the goals of the system, and the users.
	Structure	refers to the relationship among the individuals in the people component. Thus, it encompasses hierarchical and reporting structures, and reward systems.
Technical Sub-System	Process	maps the set of actions that an individual, a group or an organization must enact in order to complete an activity.
	Technology	include hardware, software, and telecommunication equipment that is used to capture, process, store, and distribute information.

2.3.1. PACT Framework

The PACT framework is crucial for designing information systems that prioritize user needs and enhance service delivery. This framework emphasizes a user-centric design approach, focusing on People, Activities, Contexts, and Technologies. Design theory is a normative or prescriptive type of theory – it gives guidelines or principles that can be followed in practice (Gregor, 2002).

Table 5: PACT Framework Components

People:	Considers user diversity and characteristics to create systems that cater to a wide range of users effectively. By addressing physical, psychological, and usage differences among users, designers can develop more inclusive and user-friendly systems. Understanding users' physical attributes, cognitive skills, personalities, and preferences is crucial in designing intuitive systems.
Activities:	Refers to the specific tasks or actions that individuals perform within different contexts using various technologies. Activities include information seeking, communication, decision-making, and problem-

	solving. Understanding user activities helps in designing systems that support and enhance these tasks.
Contexts:	Involves understanding the environments and situations in which users interact with the system. Contexts can include physical settings, social environments, and organizational conditions. Analyzing the contexts ensures that the system is suitable for various user environments.
Technologies:	Refers to the tools, devices, and systems that individuals utilize to support their activities. Technologies are categorized into input, output, communication, and content components. Understanding the role of technology helps in designing systems that align with user needs and enhance task performance.

In the context of this study, the PACT framework will be used to design an information system (IS-ASQ) for the Registrar's Office, schools, and departments at the University of Rwanda, College of Science and Technology. This system aims to collect feedback on service delivery and improve the overall user experience at the College of Science and Technology. By integrating data models and the PACT framework, this study aims to design a comprehensive information system that addresses user needs and enhances service quality within the Registrar's Office at the University of Rwanda, College of Science and Technology. This approach ensures a user-centric, efficient, and effective system that supports organizational goals and improves service delivery.

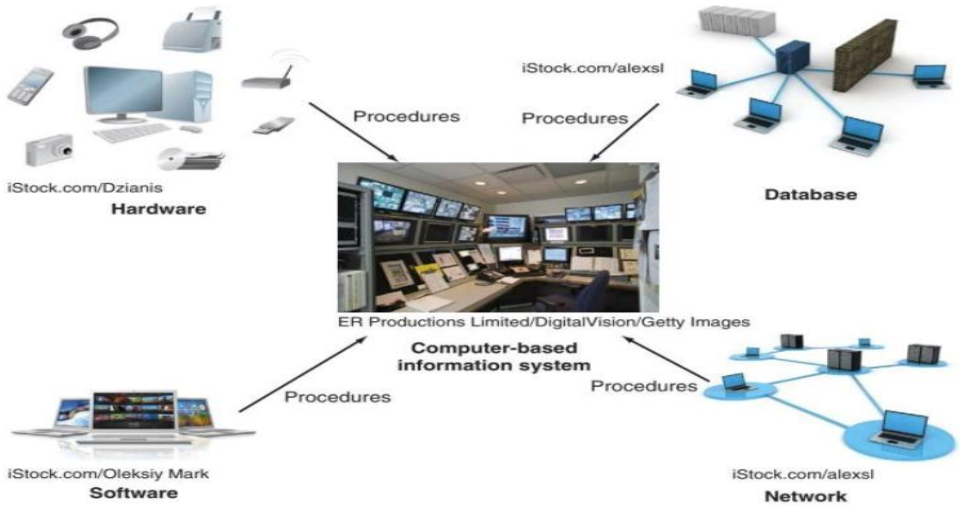

Figure 2: Technical Sub-System of Information System (R. Kelly & Brad, 2021)

2.4. Information Systems Theories

The theoretical foundations for Information Systems embody a wide range of concepts and principles from different disciplines such as computer science, management, organizational behavior, economics, sociology, and psychology. These theories emphasis in understanding how information systems is designed, implemented, used and their impact on organizations and society (Hevner R. & Chatterjee, 2010).

Table 6: Information Systems Theories and Application

Theories	Overview	Application in IS
Systems Theory	Systems theory views an organization as a complex set of interconnected components that work together to achieve a common goal.	Used to analyze how different components of an information system interact with each other and with external systems.
Socio-Technical Systems Theory	Emphasizes the interdependence between social and technical aspects of an organization.	Highlights the need to balance technical efficiency with social factors when designing and implementing information systems.

Information Theory	Focuses on the quantification, storage, and communication of information.	Provides the basis for understanding data transmission, coding, and the efficiency of information processing.
Decision Theory	Studies the principles and models of decision-making.	Applied in developing decision support systems (DSS) that assist managers in making informed decisions.
Behavioral Theories	Includes theories from psychology and sociology that explain human behavior.	Used to understand user behavior, acceptance, and resistance to information systems (e.g., Technology Acceptance Model (TAM)).
Economic Theories	Include theories like transaction cost economics and agency theory.	Helps in understanding the economic impacts of information systems, cost-benefit analysis, and outsourcing decisions.
Organizational Theory	Examines the structure, design, and culture of organizations.	Important for understanding how information systems align with organizational goals and structures (e.g., contingency theory).
Innovation Diffusion Theory	Explains how, why, and at what rate new ideas and technology spread.	Used to study the adoption and diffusion of new information technologies within organizations.
Cognitive Dissonance Theory	Proposes that people experience discomfort when they hold conflicting cognitions and are	Helps in understanding user resistance to new information systems and the importance of change management.

	motivated to reduce this dissonance.	
Ethics and Social Responsibility	Focuses on the moral principles and values that govern the use of information systems.	Addresses issues like privacy, security, and the ethical implications of IS use and data handling.
Critical Theory	Critically examines society and culture, focusing on power structures and inequalities.	Used to analyze the broader societal impacts of information systems, including issues of digital divide and information equity.

2.5. Information Systems Models.

There are different information systems models to provides a structural approach to design and develop a complex information system. These models will help in visualizing, planning and communicate various aspects of the system while ensuring that all stakeholders have a clear understanding of its architecture, components and the behavior (Pedro & Tomayess, 2015).

Table 7: Information Systems Models, use and description

Models	Features	Use	Description
Behavioral Models	Use Case Diagrams	Gathering system requirements and understanding user interactions.	Capture system functionality by showing interactions between actors and system functions.
	Sequence Diagrams	Understanding the flow of control and data across the system.	Display the sequence of messages exchanged between objects to perform a function.

	Activity Diagrams	Modeling of business processes and workflows.	Visualize the flow of activities or tasks within the system
	State Diagrams	Modeling the dynamic behavior of the system.	Represent the states of a system.
Data Models	Entity-Relationship (ER) Diagrams	Designing databases and understanding data structures.	Depict the data entities, their attributes and relationships.
	Class Diagrams	Defining the blueprint for system objects.	Outline the classes, their attributes, methods, and relationships.
Interaction Models	Communication Diagrams	Detailing object interactions and collaborations	Interactions between objects and the flow of messages.
	Collaboration Diagrams	Structural organization and interaction among objects.	Show how objects work together to achieve a particular goal.
Detailed Design Models	Flowcharts	Depicting algorithms, processes and decision paths.	Represent the flow of control.
	Pseudocode	Bridges the gap between design and implementation.	Provides a high-level, human-readable description of algorithms.

2.6. Information System Design

The design of information systems is the process of creating the structure, architecture and functionality of systems that manage and process data to support organizational objectives. It involves several stages such as requirements analysis, system architecture design, database design, software design, user interface design, integration design, security design, testing and

validation, deployment and implementation and maintenance and evaluation. The requirements analysis plays the role of understanding the user needs and the objectives by defining both the functional and non-functional requirements of the information system (R. Kelly, Brad, Cristobal, Ingrid, & Sepideh, 2020).

The system architecture design plays the role of designing the structure and components of the information system such as databases, software applications, interfaces and network infrastructure with appropriate technologies and platforms. The database design encases the creation of the database structure and its schema by tailoring the tables, fields, relationships, and constraints for efficiently storing and retrieving data. Software design is also a crucial component in the information systems design as its software components and modules will implement the system's functionality such as user interfaces, business logic and data processing algorithms (Adil, Ilenia, Ilenia, & Claus, 2022). The user interface design is a critical component in the information system design as it plays a crucial component for interacting with the user while creating intuitive and user-friendly interfaces that allow users to interact with the system effectively.

The design of user interface involves considering usability principles, user experience (UX) design and accessibility of the information system (Sauer, Sonderegger, & Schmutz, 2020). The designed system needs to be integrated with other systems to be able to function effectively hence designing the integration is also needed as the designed information will communication with other external systems such as user interfaces, protocols and data exchange formats.

The designed information system stores data that are critical to the function of the organization and the security implementation is needed hence the implementation of security measures to protect the confidentiality, integrity and availability of data and system resources with authentication, authorization, encryption, and audit for strengthening the security of the stored data (Michael & Herbert, 2012).

The functionalities of the designed information system are tested using testing and validation methods which ensure that the system meets its requirements, performs as expected and is free of defects or vulnerabilities that can allow the unauthorized accessibility. The designed information system needs also to be deployed into production with configuration for operational usage and providing support and training to the user. Through the training and support, the

monitoring and maintenance is also provided by applying updates and enhancement as needed by the user as a method of changing the requirements and technologies (Kenneth & Jane, 2019).

2.6.1. Methodological Approaches for Information System Design

The designing of information system involves different methodological approaches that guide the design, development, analysis and the deployment of the system. These methodologies provide framework and practices to ensure the system meets user needs and the business goals while being robust, scalable and maintainable. There are different methodologies to use the information system design.

2.6.1.1. Structured Systems Analysis and Design Method (SSADM)

The structured systems analysis and design method focuses on the documentation analysis which involves different stages such as the feasibility study, requirement analysis, system design and the implementation. The feasibility study plays the role of assessing the viability of the project, the requirement analysis gathers the user requirement and the required documentation, the system design creates also the physical and logical design, the implementation and testing deals with the development and the testing of the system while the maintenance deals with the support and the system enhancement. The SSADM is mostly used in the large and complex systems with stable system requirements (ASHWORTH, 1988).

2.6.1.2. Object-Oriented Analysis and Design (OOAD)

The Object-Oriented analysis and design emphases on the system modeling using the objects that reflect the real-world entities. It utilizes different iterative stages such as analysis, design and implementation using mostly the unified modeling language (UML). The stages in object-oriented analysis and design encompasses the requirement gathering, the analysis, the design, the implementation and testing. It is also suitable for the projects that employ the reuse and the modularity (Mukherjee, 2016).

2.6.1.3. Agile Methodologies

The agile methodologies emphases on the iterative system development, team collaboration and flexibility. The popular agile methodologies include the scrum, Kanban and the extreme programming. Each methodology is also subdivided into steps such as sprint planning, daily stand-ups, sprint review, sprint retrospective and the backlog refinement. The agile methodologies are mostly used in the projects that require the evolution of the project and the rapid product delivery with high stakeholders' engagement (Laoyan, 2024).

2.6.1.4. Rapid Application Development (RAD)

The rapid application development stresses on the quick development and iteration with user feedback. The rapid application development employs prototyping and user involvement to refine requirements and solution. There four steps involve in the rapid application development such as the requirement planning, user design, construction and cutover. It is mostly used on the projects that need fast delivery and frequently adjustment due to the user feedback (Kissflow, 2024).

2.6.1.5. DevOps

DevOps is the term that combine both the development (Dev) and the operations (Ops), the combination of both term short the system development life cycle. The DevOps bridges the gap between the information technology operations by eliminating the bottlenecks in the teams to be able to deliver the application on time. The DevOps enhance the team collaboration and communication. The DevOps allows the faster releases, enabling continuous testing and improve the quality of the system. It involves the planning, the development, testing, deployment and monitoring. It is useful for the projects that requires the rapid development and high reliability (atlassian, 2024).

2.6.1.6. Prototyping

The prototyping in the information system is an essential technique for designing and developing user-friendly and effective systems. It involves creating a simplified, working model of the proposed system early in the development process. The prototyping involves in creating the primary version of the system to understand the requirements and refine the functionality after. The prototyping is composed by initial requirements gathering, prototyping, user evaluation, refinement and the final system development (Siang, 2021).

2.6.1.7. Spiral Model

Spiral Model is risk-driven methodology for software development which involves planning, risk assessment, development, and evaluation. Every loop in the spiral model concentrates on reducing major risks while developing a section of the program. This iterative method is perfect for complicated or high-risk projects since it provides early user feedback and course correction (Dhruv Doshi, 2021).

2.6.1.8. Design Science Research

Design Science Research (DSR) is also a part of the methodologies used in information system design. DSR is a research paradigm that focuses on the creation and evaluation of artifacts designed to solve identified problems, making it highly relevant to information system design. Design Science Research seeks to invent (design) new means for acting in the world in order to change and improve reality. As a result, DSR re-creates reality through creating and evaluating artefacts that serve human purposes and solve human problems (Venable, Pries-Heje, & Baskerville, 2017).

Here are six recognized methodologies in DSR:

- Design Science Research Methodology (DSRM) (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008);
- Action Design Research (ADR) (Lindgren, Rossi, Purao, Henfridsson, & Sein K., 2011);
- Technology Acceptance Model (TAM) Integration (Davis, 1989);
- Hevner's Design Science in Information Systems Research (Hevner, March T., Park, & Ram, 2004);
- Design Cycle in Information Systems Research (Vijay, Bill, & Saravanaraj, 2004); and
- Action Research (AR) (Avison E., Lau, Myers D., & Nielsen A., 1999).

2.6.1.9. Summary

Selecting the right methodology for designing an information system depends on various factors such as the project size, complexity, requirements stability and the need for flexibility. Each approach offers distinct advantages and is suited to different types of projects and organizational environments. Understanding these methodologies helps in choosing the most appropriate framework to ensure successful system development.

2.7. Service Delivery

Service delivery refers to the process of providing assistance to customers or clients according to predefined standards or agreements. It involves all the activities and interactions that occur between the service provider and the customer from the initial request or inquiry to the final delivery and support. There are stages that are followed strategically in service delivery such as request, processing, execution, interaction, and feedback. Effective service delivery requires careful planning, coordination, and communication to ensure that customer expectations are met

or exceeded. It involves not only delivering the core service but also addressing customer needs, preferences, and concerns throughout the entire process. Service delivery plays a critical role in customer satisfaction, retention, and loyalty as positive experiences can lead to repeat business and referrals while poor experiences can result in lost customers and damage to the provider's reputation (Costas & Vasiliki, 2008).

2.7.1. Traditional service delivery

The traditional service delivery at the University of Rwanda, College of Science and Technology are still delivered using the traditional method such as face-to-face interactions, paper-based processes and manual procedures. These methods are deeply established in various aspects of service provision where students often engage directly with university staff through personal visits in different academic or administrative offices. This traditional model reflects common practices in educational settings by emphasizing the importance of human interaction and physical presence in shaping the student experience.

2.7.2. e-Services at Registrar's Office (MIS)

The Registrar's Office at the University of Rwanda, College of Science and Technology has fully embraced electronic services also known as e-Services. This method of service delivery is crucial aspect in registrar's office operations. These digital services cover a wide range of registrar's office tasks and procedures by focusing on improving accessibility, efficiency and timely service delivery to students and staff. The main e-Services offered at the registrar's office is the management of admission and registration processes through online platforms through the University of Rwanda's Integrated Education Business Management Information System (UR-IEBMIS).

This digital method allows students to smoothly navigate the admission process, submit required documents and complete registration using digital interfaces. Through e-Services, the Registrar's Office aims to simplify and speed up enrollment, providing a more user-friendly experience for students and this is aligned with the institution's broader goal of using technology to modernize administrative processes, improve accessibility and create a more responsive and user-focused service delivery approach.

2.8. Service Quality

Service quality is defined as a strategic tool for positioning an institution to achieve operational efficiency by enhancing overall business performance. Delivering high-quality service is crucial for service providers as it directly impacts customer satisfaction and ultimately contributes to their success (Dyah, M. Mujiya, Priska, & Nadia, 2016). Service quality involves understanding customer expectations, measuring performance against these expectations and continuously improving service delivery to meet or exceed customer needs and preferences. Different models and frameworks provide tools and methodologies for organizations to assess, analyze and enhance service quality across various dimensions and industries. It encompasses various dimensions that contribute to customer satisfaction, loyalty and overall experience. These dimensions can include reliability, responsiveness, assurance, empathy and tangibles.

2.9. Service Quality Assessment

Service quality assessment is the process of evaluating the extent to which a service meets or exceeds customer expectations. It involves systematically measuring various aspects of service delivery to identify strengths and weaknesses by understanding customer perceptions and pinpointing the areas for improvement. It involves gathering feedback from customers through surveys, interviews or other feedback mechanisms and also analyzing the obtained data against established service quality standards. The main Key dimensions assessed include reliability, responsiveness, assurance, empathy, tangibles and some additional dimensions specific to the service. The goal of service quality assessment is to ensure that service providers can consistently deliver high-quality services that meet or exceed customer expectations, thereby fostering customer satisfaction, loyalty and positive organizational outcomes while maintaining the institution reputation.

2.9.1. Paper-Based Service Quality Assessment Frameworks

2.9.1.1. SERVQUAL Assessment Framework

In 1985, Parasuraman, Zeithaml, and Berry introduced SERVQUAL, a method for assessing perceived service quality. It measures customers' expectations against their actual experiences during a service encounter, highlighting the gap between expectation and perception as a metric of service quality (Naziyet, 2015). The SERVQUAL framework also has five key dimensions of service quality such as reliability, responsiveness, assurance, empathy and tangibles. Reliability

is the ability of the service provider to deliver services consistently and accurately. Responsiveness relates to the willingness and promptness of the provider to address customer needs and concerns. Assurance refers to the competence, courtesy and credibility of service personnel. Empathy reflects the provider's ability to understand and empathize with customers' individual circumstances.

Tangibles encompass the physical facilities, equipment and communication materials associated with the service. (C.N. Krishna, Swapna, & Gantasala, 2010).

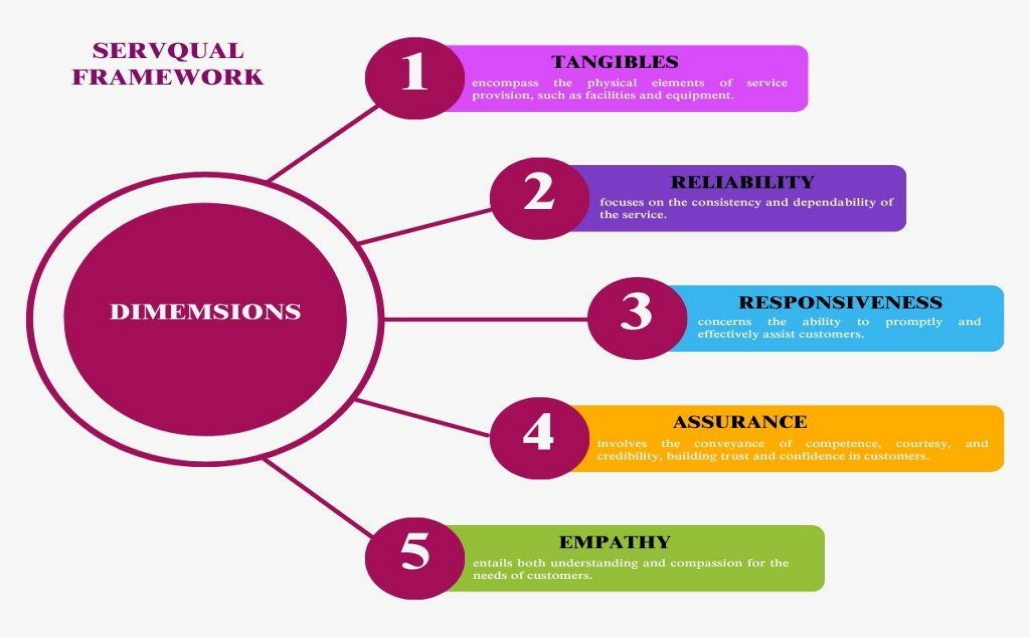

Figure 3: SERVQUAL Framework *(C.N. Krishna, Swapna, & Gantasala, 2010)*

It employs a questionnaire-based approach to measure service quality. Customers are asked to rate their expectations and perceptions of service delivery across the five dimensions allowing for a quantitative assessment of the gaps between expected and perceived service quality. This gap analysis provides valuable insights into areas where service improvements are needed to meet customer expectations more effectively (Ismail, 2008).

The SERVQUAL framework facilitates benchmarking and comparison across different service providers and industries by standardizing the dimensions used to assess service quality while enabling organizations to evaluate their performance relative to competitors and industry standards. This benchmarking process can inform strategic decision-making and help companies

prioritize initiatives to enhance their competitive position in the marketplace by focusing on customer expectations and perceptions across key dimensions of service delivery; it provides actionable insights that can drive continuous improvement and enhance the overall customer experience.

2.9.1.2. SERVPERF Assessment Framework

The SERVPERF framework is a model developed by Valarie Zeithaml, A. Parasuraman, and Leonard Berry. It is an extension of the widely recognized SERVQUAL model focusing specifically on assessing service quality by examining customer perceptions of service performance. The SERVQUAL compares perceived service quality to customer expectations and SERVPERF only focuses on performance-based evaluations. The SERVPERF framework lies on the concept of service quality as perceived by customers which suggests that the customers evaluate service quality based on their experiences during service delivery rather than by comparing those experiences to preconceived expectations. This shift in perspective emphasizes the importance of delivering consistent and reliable service performance to meet customer needs and preferences (M. Sadiq & Mehedi, 2019).

The SERVPERF framework uses five key dimensions for evaluating service performance such as reliability, responsiveness, assurance, empathy, and tangibles. These dimensions represent different facets of the service encounter that influence customer perceptions of quality. Reliability refers to the ability of the service provider to deliver services consistently and accurately. Responsiveness is related to the promptness and willingness of the provider to address customer needs and concerns. Assurance pertains to the competence, courtesy, and credibility of service personnel. Empathy reflects the provider's ability to understand and empathize with customers' circumstances and the Tangibles encompass the physical facilities, equipment, and communication materials associated with the service.

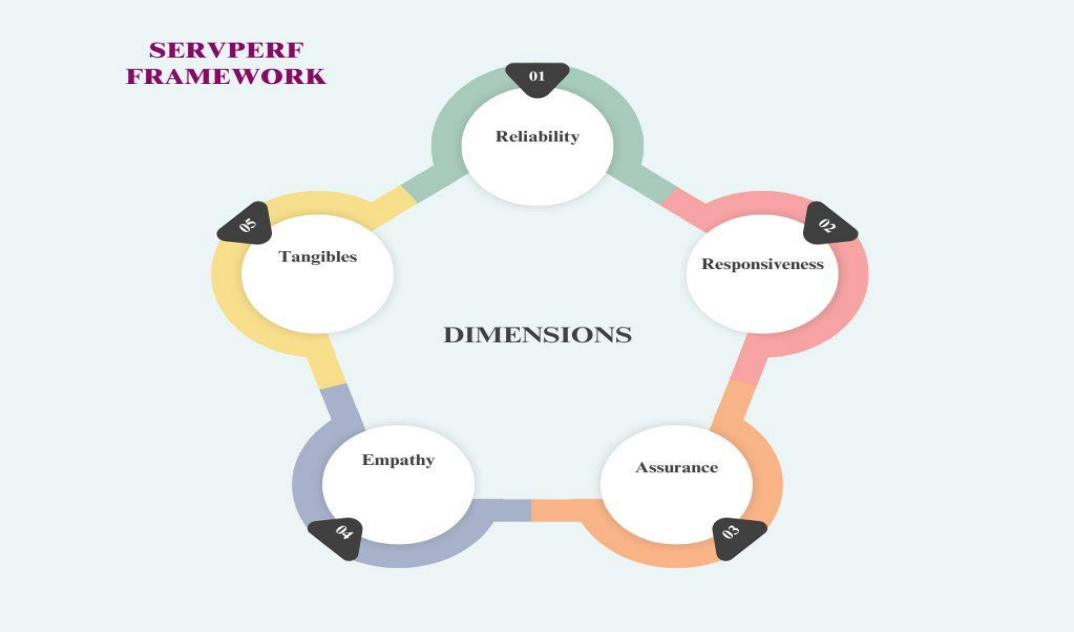

Figure 4: SERVPERF Framework *(Gennaro, 2023)*

The strengths of the SERVPERF framework are its simplicity and applicability across diverse service industries. By focusing on performance-based evaluations rather than customer expectations, it provides a more objective and actionable approach to measuring service quality. This makes it particularly valuable for service providers seeking to identify areas for improvement and enhance the overall customer experience. Its SERVPERF framework enables organizations to evaluate their performance relative to competitors and industry standards. This, in turn, can inform strategic decision-making and help companies prioritize initiatives to enhance their competitive position in the marketplace (Mohd. Adil, 2013).

2.9.1.3. Customer Satisfaction Index (CSI) Framework

The Customer Satisfaction Index (CSI) is like a score that shows how happy customers are with a company's products or services. To calculate this score, customers are asked to share how satisfied they are with different parts of the product or service. Customer satisfaction is defined as evaluating how well products or services meet or exceed client expectations. It also encompasses the client's mood or attitude towards a product or service after it has been used (Sao Mai & Tri Cuong, 2021), the authors emphasized the pivotal nature of customer satisfaction by elucidating its role in evaluating how well products or services meet or exceed client expectations. Their research underscores the significance of customer mood and attitude towards

a product or service after its usage, highlighting the multifaceted nature of customer satisfaction assessment.

Customer satisfaction is an intricate concept that encompasses not only the functional performance of products or services but also the emotional and perceptual dimensions of the customer experience. The evaluation of customer satisfaction delves into how effectively the products or services fulfill customer needs and desires beyond mere functionality. This holistic approach considers the overall experience and the after-effects of utilizing the product or service, providing a more nuanced understanding of customer sentiments. Maintaining high-quality standards for services can lead to increased customer loyalty and a positive reputation (Process.st, 2024). Factors that can affect CSI, include the quality of the service, and customer service.

Table 8: Factors That Affect CSI (Process.st, 2024)

1. Quality of Service	Evaluate the current quality standards and identify areas for improvement. Set clear quality objectives and performance targets for products or services. Implement quality control measures at every stage of production or service delivery. Regularly review customer feedback and adjust product or service quality based on insights.
2. Customer Service	Listen to customer feedback attentively. Address customer issues promptly and efficiently in order to provide top-notch customer service. Train support staff to be empathetic and solution-oriented, ensuring that all customer concerns are handled with care and efficiency. Establish clear communication channels for customers to easily reach out with any issues or concerns they may have regarding our products or services.

Table 9: Other Paper-based Service Quality frameworks

Authors	Year	Model	Descriptions
JOHN FLANAGAN	1954	CRITICAL INCIDENT TECHNIQUE (CIT)	CIT focuses on collecting narrative descriptions of particularly positive or negative incidents experienced by customers.
MARY JO BITNER	1992	SERVICESCAPE	SERVICESCAPE uses a paper-based methods that focuses on collecting customers and employees' perceptions and evaluation on the physical elements through structured surveys and feedback forms.
ISO	1987	ISO 9001 CUSTOMER SATISFACTION MEASUREMENT	ISO 9001 includes guidelines for measuring customer satisfaction as a key performance indicator of the quality management system. It follows a structured process to gather, analyze and act on customer feedback.
FRED REICHHELD	2003	NET PROMOTER SCORE (NPS)	NPS involves distributing physical survey forms to customers and collecting their responses. The process includes designing the forms, distribution and analyzing the results and gain insights for improvement.

2.9.2. Electronic Service Quality Assessment Frameworks

Electronic service quality (e-service quality) has become more important, especially since the outbreak of the Covid-19 pandemic, which has led to an increase in the importance of electronic services, which in turn could reshape customer expectations, perceptions, and satisfaction toward e-services, and businesses' behavior towards the evolution of the e-services market. According

to (Sadaf & Rahela, 2019), the e-service quality is a field where there is a possibility to provide efficient and effective services to users through electronic media. When assessing electronic service quality, E-RecS-Qual and E-S-Qual frameworks are the best ones to pinpoint the essential dimensions that define e-service quality for a specific online service.

2.9.2.1. E-S-Qual Framework

The e-S-QUAL (Electronic Service Quality) framework is one of the most widely used instruments for measuring the quality of websites, e-commerce and other online services (Anas, et al., 2022). At the early stage of developing e-S-QUAL, there was inconsistency in the use of the term e-commerce; in web-based transactional services, they are defined as online transactions, so it is one of the areas that are often used in the research. Based on the original SERVQUAL scale, e-S-QUAL develops 12 original items to assess the five dimensions of e-service quality: eight indicators under the title of website & web commerce dimensions, with the remainder under the title of core dimensions. Therefore, achieving a high level of e-service quality always involves investing in web quality and other infrastructure facilities that help the customer recognize a high level of service quality. With excellent connectivity, the organization transmits a sense of trust in the reliability and performance of services, creating a strong, competitive position in the market (Anas, et al., 2022).

2.9.2.2. E-RecS-Qual Framework

The E-RecS-Qual multi-level version of an e-service quality conceptual model was applied in the offline framework of traditional service quality because both standard and e-services contain both customer-staff interactions and certain non-human relationships. This research purpose discovers traditional service quality conceptual model input elements to assess user behavior. Participants completed e-rec-s-qual surveys involving the retail industry site where they conducted an offline and online evaluation of purchased apparel and completed traditional SERVQUAL user feedback on their purpose of going to the mall to buy apparel services (Laura & Wolfgang, 2014).

2.9.2.3. Customer Satisfaction Score (CSS) Framework

Customer Satisfaction Score (CSS) is another instrument for electronic service quality assessment applied to appraise the helpfulness and quality of the site and its practicability. The CSS is obtained on the basis of two questions—whether participants feel satisfied with the

quality of the website and whether participants would recommend the website to others. Website service quality helps to evaluate 'how well' the website does what is necessary to satisfy its users. It includes convenience of the navigation, response speed and correctness of website material and functionalities in serving the website users (Norman, Brenda, & Daniel, 2022).

2.9.2.4. Web Analytics Framework

Web analytics is an essential tool for measuring and analyzing customer engagement on websites. By tracking user behavior, such as page views, clicks, and session duration, web analytics provides insights into how users interact with web content. This data is crucial for identifying key areas for improvement in website content and design. For example, high bounce rates may indicate that content is not meeting user expectations, while low conversion rates might suggest that the user interface needs refinement. By leveraging these insights, businesses can optimize their websites to enhance user experience, increase engagement, and achieve better conversion rates (Joel & Heikki, 2015).

Table 10: Other Electronic Service Quality Assessment Frameworks

Authors	Years	Model	Descriptions
Professor Noriaki Kano	1980	CUSTOMER SATISFACTION SCORE (CSAT)	CSAT typically involves asking customers to rate their satisfaction with a specific interaction or experience in organization on a numerical scale.
Harvard Business Review	2010	CUSTOMER EFFORT SCORE (CES)	CES surveys typically ask customers to rate the ease of completing a task or resolving an issue in an organization on a numerical scale.
Not specified	2000	SOCIAL MEDIA MONITORING	This model analyzes the customer feedback and sentiment on social media platforms.
Jure Leskovec, Anirban Dasgupta, Ravi Kumar and Jon Kleinberg	2007	ONLINE REVIEW AND RATING	This model collects and analyse the customer reviews and ratings on different platforms.

Aditya Pal, Andrew Begel and Thomas Zimmermann.	2017	MOBILE APP FEEDBACK	This model gathers the customers feedback using mobile application directly.
SurveyMonkey	1999	AUTOMATED CUSTOMER FEEDBACK SYSTEMS	This model uses the automated systems to collect customers feedback via email, SMS or chatbots interactions.

CHAPTER 3. RESEARCH METHODOLOGY

3.1. Research Design

To thoroughly explore and design an Information System for Assessing Service Quality at the University of Rwanda, College of Science and Technology, case of selected services, this research used a mixed-method approach, combining qualitative and quantitative methods.

3.1.1. Mixed-Methods Approach and Rationale

The mixed-methods approach was chosen due to its ability to provide a deeper understanding of the complex phenomena associated with service quality assessment in the UR, College of Science and Technology. Objective 1 (To understand the design of an information system for assessing service quality) was achieved through textual analysis of the articles during the literature review part of this research. Objective 2 (To identify the requirements of an information system for assessing service quality) was achieved using both qualitative and quantitative approaches through surveys, interviews, and brainstorming. Objective 3 (To design the information system for assessing the service quality of the selected services in the college's registrar's office, departments, and schools) was achieved through the design of the interfaces we have in Chapter 5 of this research. By integrating both qualitative and quantitative methods, this study captured diverse perspectives, contextual nuances, and quantitative metrics essential for designing an effective service quality assessment system (Creswell & Creswell, 2017).

This research employed a mixed-methods approach to improve the quality of service delivery to stakeholders and feedback mechanisms within the selected services of the University of Rwanda, College of Science and Technology registrar's office, schools, and departments. By conducting a primary survey on service delivery at these units, we identified areas for improvement in the information system design for service quality assessment. Through qualitative methods such as interviews and focus groups, we explored stakeholder experiences, perceptions, and expectations. Quantitative methods, including questionnaires, quantified service quality perceptions, satisfaction levels, and performance metrics. This comprehensive approach enabled us to identify the system requirements and design characteristics of IS-ASQ tailored to the university's services. Finally, we designed an information system for assessing the service quality of the selected services in the college's registrar's office, departments, and schools. The synergy between qualitative insights and quantitative data enhanced the validity and reliability

of the research findings, addressing research questions related to stakeholder satisfaction, service quality indicators, and the effectiveness of service delivery (Creswell & Creswell, 2017).

3.2. Data collection

Data collection is a pivotal phase in research serving as the foundation for generating meaningful insights and drawing valid conclusions. It involves systematically gathering data from various sources such as surveys, interviews, observations, or existing datasets, depending on the research objectives and research questions (Creswell & Creswell, 2017). For this research, surveys, and interviews will be used to collect data from personnel in the Registrar's Office, department, students, and academic staff.

Between May and June 2024, we conducted a total of 160 interviews. Out of these, 112 were completed, including 18 academic staff members, 4 personnel from the college registrar's office, and 90 students

3.2.1. Data Collection Techniques

3.2.1.1. Interview

An interview is a qualitative research method that relies on asking questions to collect data. It involves two or more people, one of whom is the interviewer, asking the questions, and the other is the interviewee, giving the responses. Interviews were conducted between the researcher and the above-mentioned stakeholders from the University of Rwanda at the School of ICT College of Science and Technology, where prepared survey questionnaires were answered (Neha, 2021).

A survey questionnaire is the actual document or form that is used to collect the data. It typically includes a series of questions or prompts that are designed to elicit specific information from participants. Crafting effective survey questions is crucial for ensuring the reliability of collected data, as the quality of questions directly impacts the quality of responses. Questions within a survey can be broadly categorized as either open or closed. Closed questions present respondents with a predetermined set of response options such as yes/no, multiple-choice, checkboxes, or Likert scale questions. Open questions allow respondents to provide unrestricted answers, often in the form of essays or brief responses (Neha, 2021).

3.3. Data Analysis Techniques

3.3.1. Analytical Approaches for Data Collection

The researcher followed a structured approach in applying thematic analysis: interviews were conducted. The researcher then consolidated all collected data into a single file, categorizing them as initial codes, categories, and themes using key phrases or words from the highlighted texts.

Following this, the researcher systematically reviewed the transcript, grouping and regrouping similar and dissimilar codes, and appropriately relabeling them. Each category's meaning codes and themes were reviewed, with adjustments and reordering made as necessary. This iterative process was repeated multiple times to ensure a robust interpretation of the data.

3.4. Design and Development

In this stage, the research methodology employed in designing IS-ASQ is outlined. The chosen approach is Human-Centered Design (HCD), a methodology that places the needs, behaviors, and preferences of end-users at the forefront of the design process. This approach involves the following activities (Harte, et al., 2017):

• Understanding and specifying the context of use.
• Specifying the user requirements.
• Producing design solutions to meet these requirements.
• Evaluating the design against the requirements

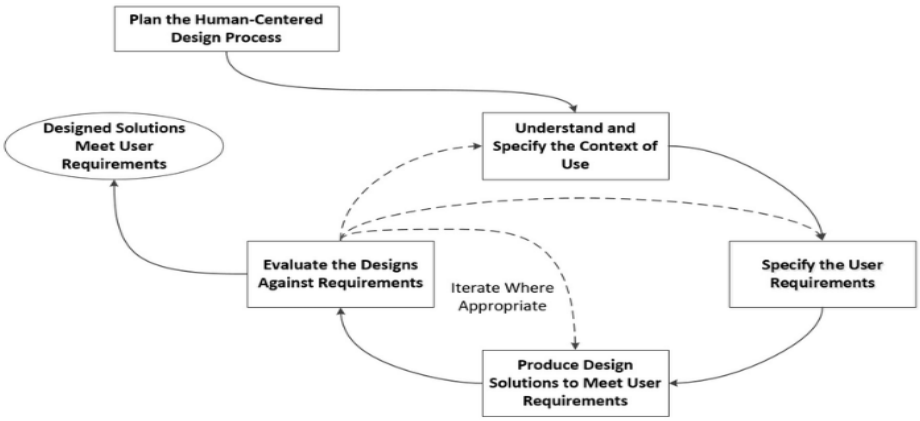

Figure 5: The Four Phases of Human-Centered Design *(Harte, et al., 2017)*

3.4.1. Understanding and Specify the Context of Use

This phase helps to gain a deep understanding of the context in which the system will be used, including the environment, tasks, and user characteristics (Maguire, 2001) (Aurora, Yuri, Demis, & Claus-Christian, 2023).

Techniques:

- Interview: Interviews were conducted with three categories of college stakeholders namely, students, academic staff in schools and departments, and personnel in the registrar's office to gather insights into their needs, challenges, and expectations (Floyd & Fowler, 2013).
- Use Cases: Develop detailed scenarios that describe how users interact with the system in different situations, helping to identify functional requirements and user goals (Aurora, Yuri, Demis, & Claus-Christian, 2023).

3.4.2. Specify the User Requirements

This phase helps to translate insights gathered from the context of use analysis into specific, actionable requirements that guide the design process.

Techniques:

- User Stories: Write user-centered narratives that describe the desired functionality from the perspective of the end-user, focusing on their goals, motivations, and expected outcomes (Anne M., Blaine, & Judith, 2013).
- Task Analysis: Break down complex tasks into smaller, more manageable steps to identify the specific actions and interactions required to accomplish them (Laura G. & Robert J., 2010).

3.4.3. Producing Design Solutions to Meet User Requirements

This phase helps to generate and explore potential design solutions that address the identified user requirements and enhance the user experience.

Techniques:

- Brainstorming Sessions: The researcher organized group brainstorming sessions to generate a wide range of ideas and concepts for the design solution.

Figure 6: Picture showing conducted brainstorming between students

3.5. System Architectural Design

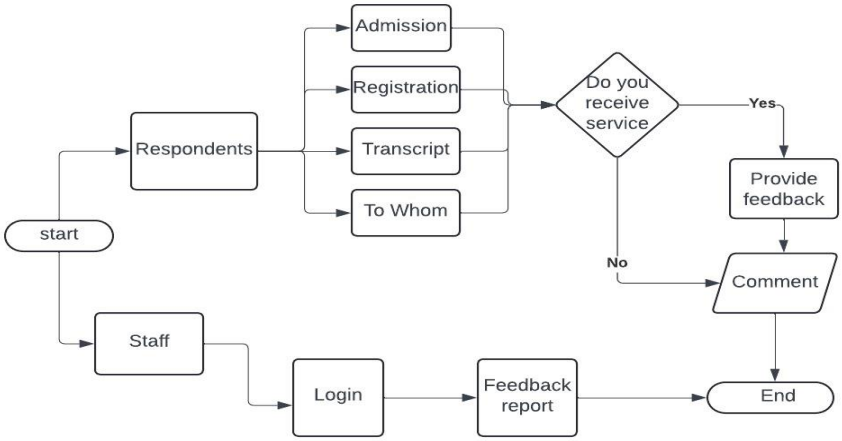

Figure 7: Picture Architectural Design of IS-ASQ

As shown on the above figure, the respondents go on the system and select the service they want to assess, by rating the service quality. We have the scope of four services namely, Admission, Registration, Transcript, and to Whom It may concern. There is also a panel where staff can log in to the system and see the feedback report according to their department under responsibility.

3.6. Software Development Life Cycle Models

Software Development Life Cycle (SDLC) Models serve as frameworks for designing, developing, and testing software projects. They delineate the prescribed methodologies to be

adhered to throughout the software development process (Iqbal S. & Idrees, 2017). The following figure is a graphical representation of the various stages of a typical SDLC.

Figure 8: Software Development Life Cycle (SDLC) *(Namira, 2023)*

Among the various SDLC Models, the Agile Model will be used in this research work, the project is split into iterations known as sprints, and corrections of functional requirements are implemented into the development process to provide competitiveness and maximize the efficiency of the IS-ASQ system.

3.7. Technology and Tools

To design the Information System for Assessing Service Quality (IS-ASQ) at the University of Rwanda, College of Science and Technology, we will use HTML5, CSS3, and React.js for a responsive front end. The back-end will be developed with PHP and the Laravel framework, while MySQL will manage the database. RESTful APIs will integrate third-party services and additional functionalities like email and SMS notifications. The IS-ASQ system will be hosted on Microsoft Azure for scalability. Global Information Tracker (Git) will ensure effective version control and collaborative development.

3.8. Implementation Plan

The following Tables outline the phases, time, budget, and activities for developing and deploying the IS-ASQ. Each phase is designed to ensure the system meets user needs and enhances service delivery at the UR, CST.

Table 11: Phase 1, Phase 2, and Phase 3 of the implementation plan

Phase 1: **Planning and Analysis** - ***Time: 8 weeks*** - ***Budget: 600 USD***	**Phase 2:** **Design** - ***Time: 4 weeks*** - ***Budget: 200 USD***	**Phase 3:** **Development** - ***Time: 6 weeks*** - ***Budget: 500 USD***
• Conduct interviews with stakeholders; • Document functional and non-functional requirements; • Identify key indicators for good service delivery; and • Assess technical, economic, and operational feasibility	• Create system diagrams; and • Design the user interface (UI) mockups using Figma.	• Develop UI using HTML5, CSS3, and React.js; • Set up the server-side environment using PHP and Laravel; • Develop core functionalities and APIs; • Integrate MySQL for database management; and • Integrate front-end and back-end components.

Table 12: Phase 4, Phase 5, and Phase 6 of the implementation plan

Phase 4: **Testing** - ***Time: 2 weeks*** - ***Budget: 150 USD***	**Phase 5:** **Deployment** - ***Time: 3 weeks*** - ***Budget: 250 USD***	**Phase 6:** **Maintenance and Support** - ***Time: N/S*** - ***Budget: N/S***
• Conduct end-to-end testing of the complete system; • Identify and fix bugs or issues; • Get feedback from a group of end-users; and • Make necessary adjustments based on user feedback.	• Set up the production environment on AWS or Azure; • Ensure all security measures and configurations are in place; • Deploy the system to the production environment; and • Monitor the initial launch for any issues.	• Maintenance and Support; and • Implement regular updates and improvements based on user feedback and performance metrics.

CHAPTER 4. SYSTEM ANALYSIS AND DESIGN MODELS FOR IS-ASQ

Interviews were conducted with three categories of college stakeholders: the students, the Registrar`s Office Admin staff, and the Academics of the UR, College of Science and Technology. A total of 160 participants were targeted while only 112 (4 personnel in the college's registrar's office, 18 academic staff, and 90 students) were meaningfully synthesized. The key indicators were coded as follows:

Table 13: Responses from Category A Participants

	Category A			
Indicator	**Section 1**		**Section 2**	
Need for both online based feedback mechanism and digitalization of services	YES	98	YES	99
	Neutral	0.7	Neutral	0.15
	NO	1.3	NO	0.85

Table 14: Responses from Category B Participants

	Category B			
Indicator	**Section 1**		**Section 2**	
Automation of transcripts and "to whom it may concern" letter	YES	95	YES	90.7
	Neutral	3.5	Neutral	6.7
	NO	1.5	NO	2.6

Considering Table 11 and Table 12 above, it is inferred that all participants at a rate of 95.7% prefer having both an online based feedback mechanism and digitalization for services rendered within the College.

Table 15: Responses from Brainstorming and Interview Sessions

	Category C	
Indicator	**Students**	**Staff**
Mode of Identification	No ID record	Official E-mail and Passcode
Necessary Component for the IS-ASQ	**Interested Services**	**Interested Components**
	Admission, Registration, Transcript and To whom it may concern	View Report

The following requirements were recommended to be addressed by the design: response at real time, report generation, security, reliability, inform decision maker, and mobility.

The system analysis and design phase is crucial for identifying the most relevant models and diagrams to be utilized during the implementation of the Information System for Assessing Service Quality (IS-ASQ) at the University of Rwanda, College of Science and Technology. The following diagrams have been defined for this purpose:

- Use Case Diagram;
- Data Flow Diagram (DFD);
- Entity Relationship Diagram (ERD); and
- Deployment Diagram.

These diagrams collectively provide a comprehensive understanding of the system's functional requirements, data flow, and database structure. The Use Case Diagram captures user interactions, the DFD visualizes data processes, and the ERD models the database. Together, they ensure the system is well-designed to meet the needs of assessing service quality at the University of Rwanda, College of Science and Technology. By using these diagrams, the IS-

ASQ system can be designed to effectively collect, process, and utilize feedback to improve service quality, ultimately enhancing the overall user experience.

4.1. Use Case Diagram

The Use Case Diagram is a powerful tool used to illustrate the functional requirements of the IS-ASQ system at the University of Rwanda, College of Science and Technology. It provides a visual representation of the different interactions between users and the system. The Use Case Diagram helps to capture the high-level functionalities and ensure all user interactions are accounted for during system development.

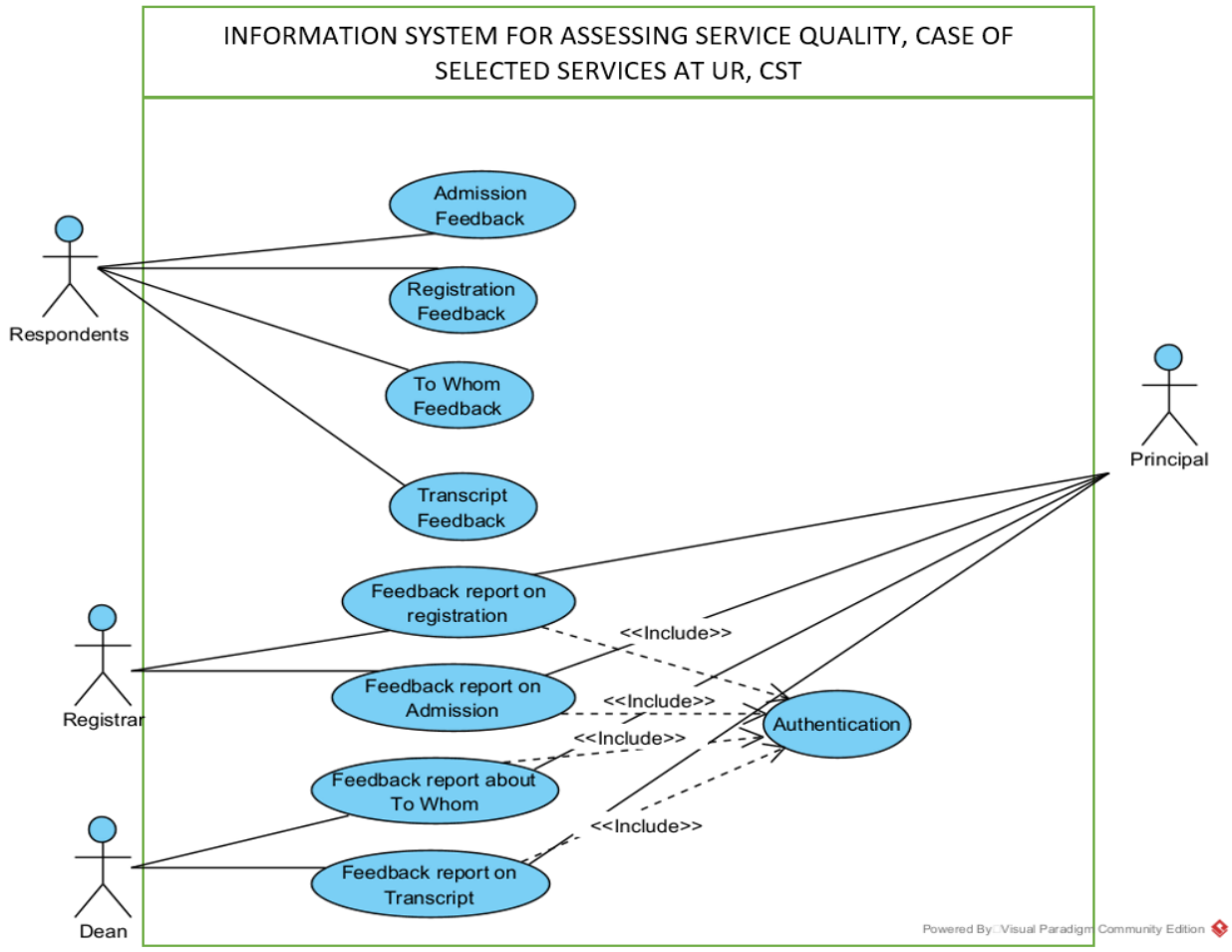

Figure 9: Use Case Design of IS-ASQ

4.2. Data Flow Diagram

A Data Flow Diagram (DFD) is used to visualize the flow of information within the IS-ASQ system. It shows how data moves through the system, the processes it undergoes, and the data stores involved. The DFD ensures that all data processes are identified and mapped out, providing a clear understanding of how information is handled within the IS-ASQ system.

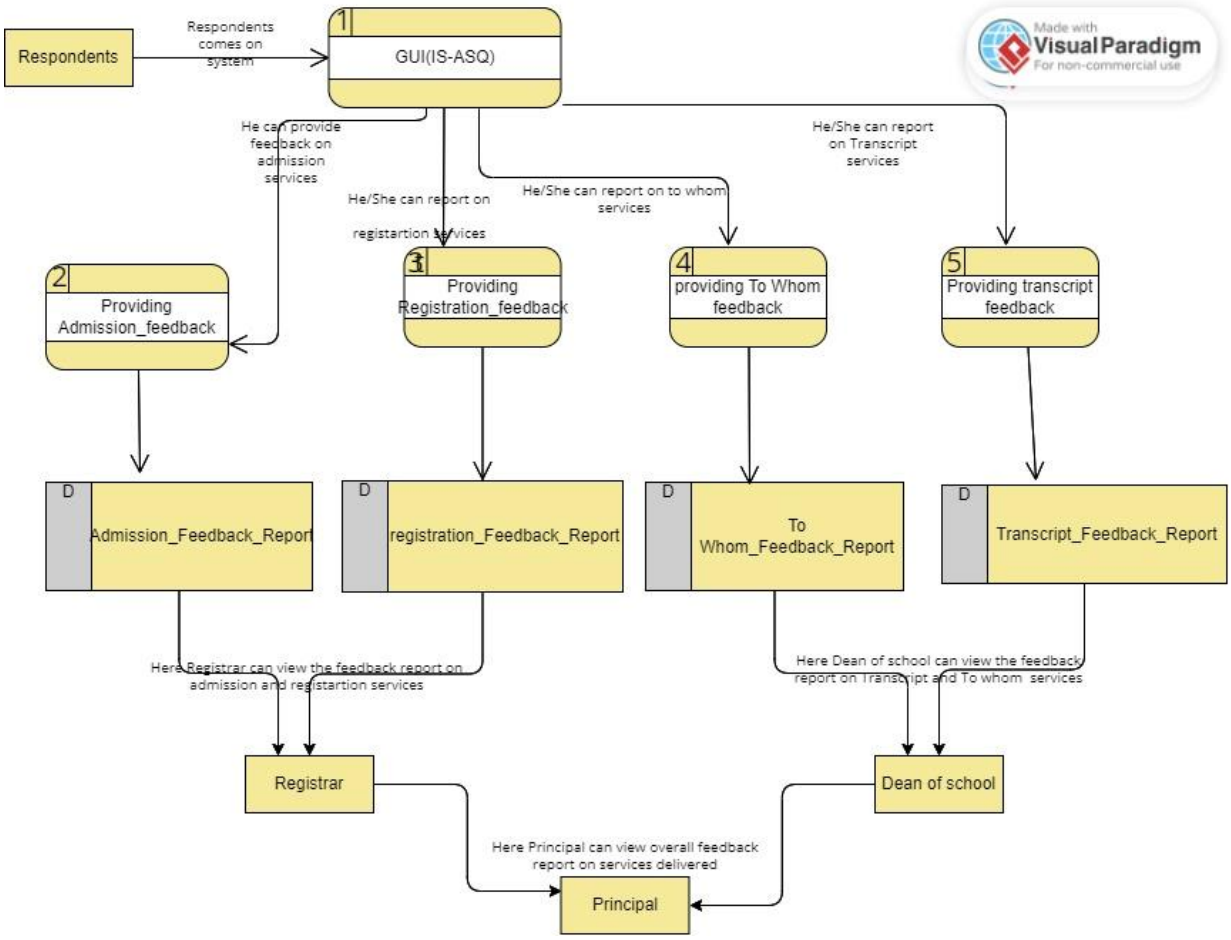

Figure 10: Data Flow Diagram of IS-ASQ

4.3. Entity Relationship Diagram

An Entity Relationship Diagram (ERD) is used to model the database structure of the IS-ASQ system. It defines the entities involved, their attributes, and the relationships between them. The ERD is crucial for designing the database schema and ensuring data integrity and efficient data management within the IS-ASQ system.

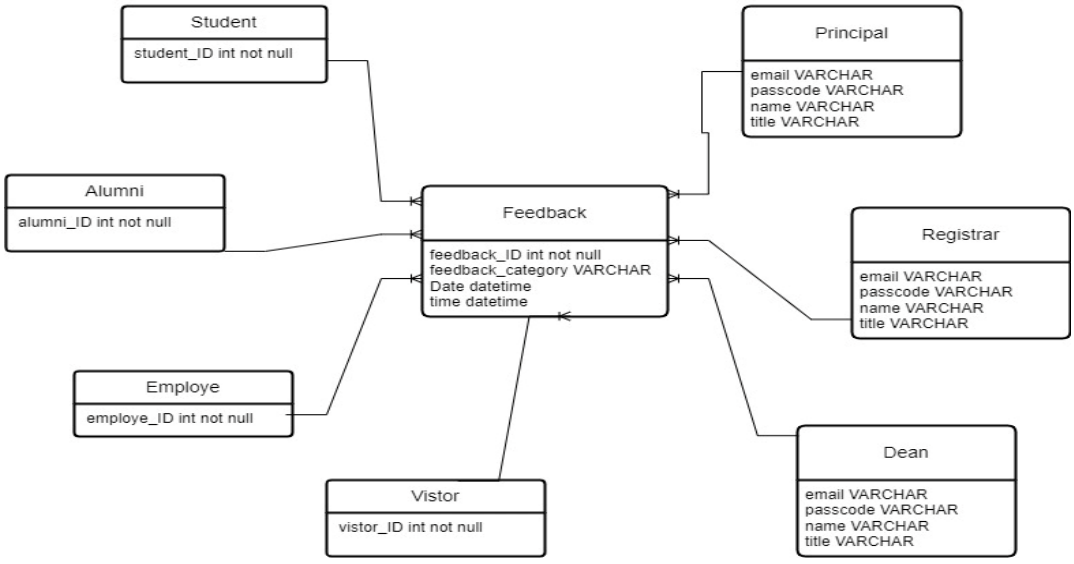

Figure 11: Entity Relationship Diagram of IS-ASQ

4.4. Deployment Diagram

This diagram displays the hardware and software components involved in the entire system, mapping out how the software will be deployed on the hardware.

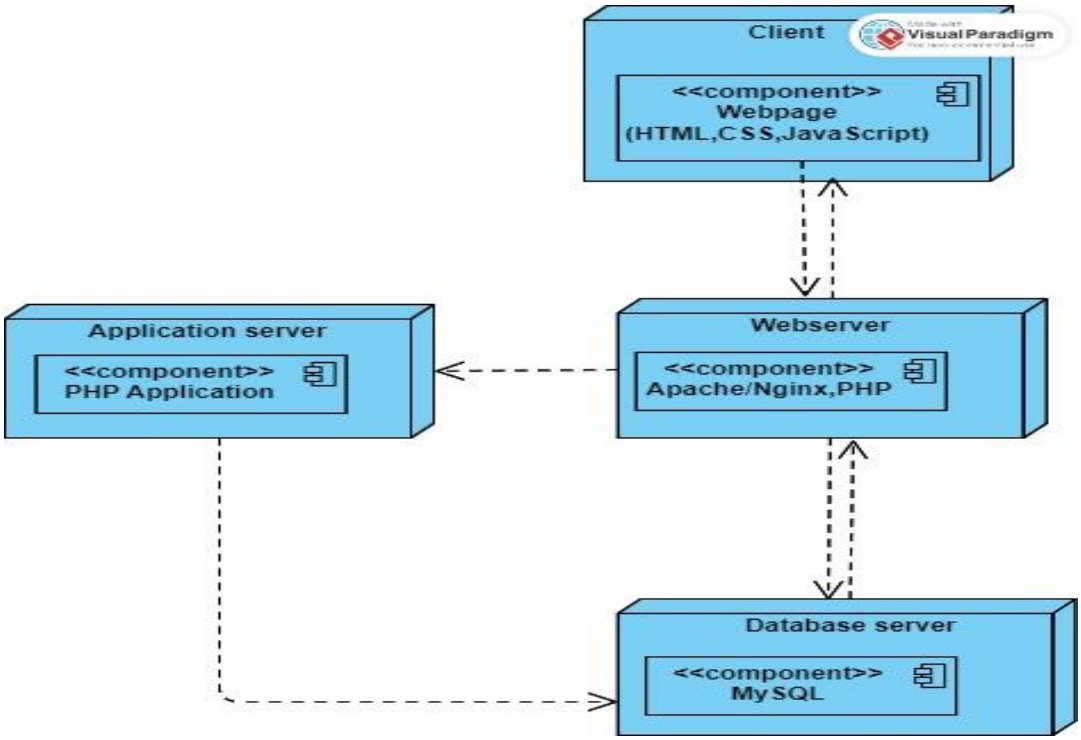

Figure 12: Deployment Diagram of IS-ASQ

CHAPTER 5. THE RESULTS

5.1. Basics of Information System Design for Service Quality Assessment

After consulting several works of literature, it was observed that Adil *et al* (2022), and Sauer *et al* (2020), among others have proved to be more reliable in terms of good service delivery which is more efficient for customer satisfaction, hence giving more understanding to what a service quality assessment should address. For instance, usability, convenience, and response time are some of the factors that are critical to good information system design for service assessment. Usability addresses how friendly the system is, convenience addresses the location of the system user, and can even interact with the system from the comfort of his/her home. The system can easily generate real-time responses to address students' requests from its database. From the above objective 1 (**To understand the design of an information system for assessing service quality**) has been achieved.

5.2. Information System Requirements for Assessing Service Quality

Specific requirements that should be incorporated into a customized system for service quality assessment within the University of Rwanda, College of Science and Technology were elicited through the interviews and brainstorming conducted on students and personnel in charge of those services which include admission, registration, issuance of transcripts and “To Whom It May Concern” letter among others. From the responses obtained during the interviews and Brainstorming sections as presented in Table 13, both the students and staff have agreed to have IS-ASQ based on their responses to the questions during the interviews 99% of students said yes to IS-ASQ. In comparison, 98% of staff also needed such services, and 0.85% of students said that they prefer paper-based services because the school is closer to their house. In comparison, 1.3% of staff maintained that they will prefer paper-based services so that they will only work at the office to avoid children`s disturbances at home. But 0.15% and 0.7% of the students and staff respectively were neutral (did not give either opinion about liking the online services or not).

Table 14, both the students and staff have accepted that the transcript and “to whom it may concern” services issuance should be automated. 90.7% of students and 95% of staff respectively said yes to automation. While 2.6% of students and 1.5% of the staff said no to the automation of those services. The staff argued that it could be difficult for them to append their signature online. In all, 6/7% of students and 3.5% of staff were indifferent to both choices.

There were recommendations as noted in Table 14 during the brainstorming and interview sessions that the design should include the following features:

For Identification, the e students prefer anonymity while the staff recommended that, there should be a means of access to the reports given by the students. The students recommended also to have these services such as admission, registration, transcript, and "to whom it may concern" issuance, among others in digital form. The staff only prefer to have the viewing privilege role since they are going to be deciding on the students' reports.

Thematic Analysis – From the Brainstorming and interview sessions, 100% of the staff participated agreed that the system design should address the following concerns: response in real-time, report generation, security, reliability, inform decision-maker, and mobility. While 30% of the students maintained that they don't care about report generation and decision-making aspect of the question, other maintained that it is a nice feature to have within the design. The requirements as identifies through the brainstorming and the interview could be classified into functional and non-functional requirement of the system.

Functional requirements – the system should capture real-time data, generate reports, and support decision-making of the college.

Non-functional requirements – the system should address the issues of security, reliability, and mobility.

With these requirements gathered from the interviews and brainstorming sessions, objective 2 (**To identify the requirements of an information system for assessing service quality**) has been addressed.

5.3. IS-ASQ Design

In designing the IS-ASQ, Human-Centered Design (HCD) was employed to prioritize the needs, behaviors, and preferences of end-users, ensuring that the design is intuitive, effective, and aligned with user expectations. This approach was integral to achieving the third objective, which focused on designing user interfaces for IS-ASQ. The designed interfaces of IS-ASQ were achieved using Figma software to include features such as login authentication, among others that are presented below:

5.3.1. Home page

This is the first entry point of IS-ASQ which shows two options: respondents option for anyone wanting to give feedback, and staff option for concerned service providers wanting to view the assessment report.

Figure 13: Home Page of IS-ASQ

5.3.2. Page of Respondents Categories

IS-ASQ respondents are grouped into 4 categories, namely: student for all active students, Alumni for former students, employee for all staff, and visitor for all other stakeholders.

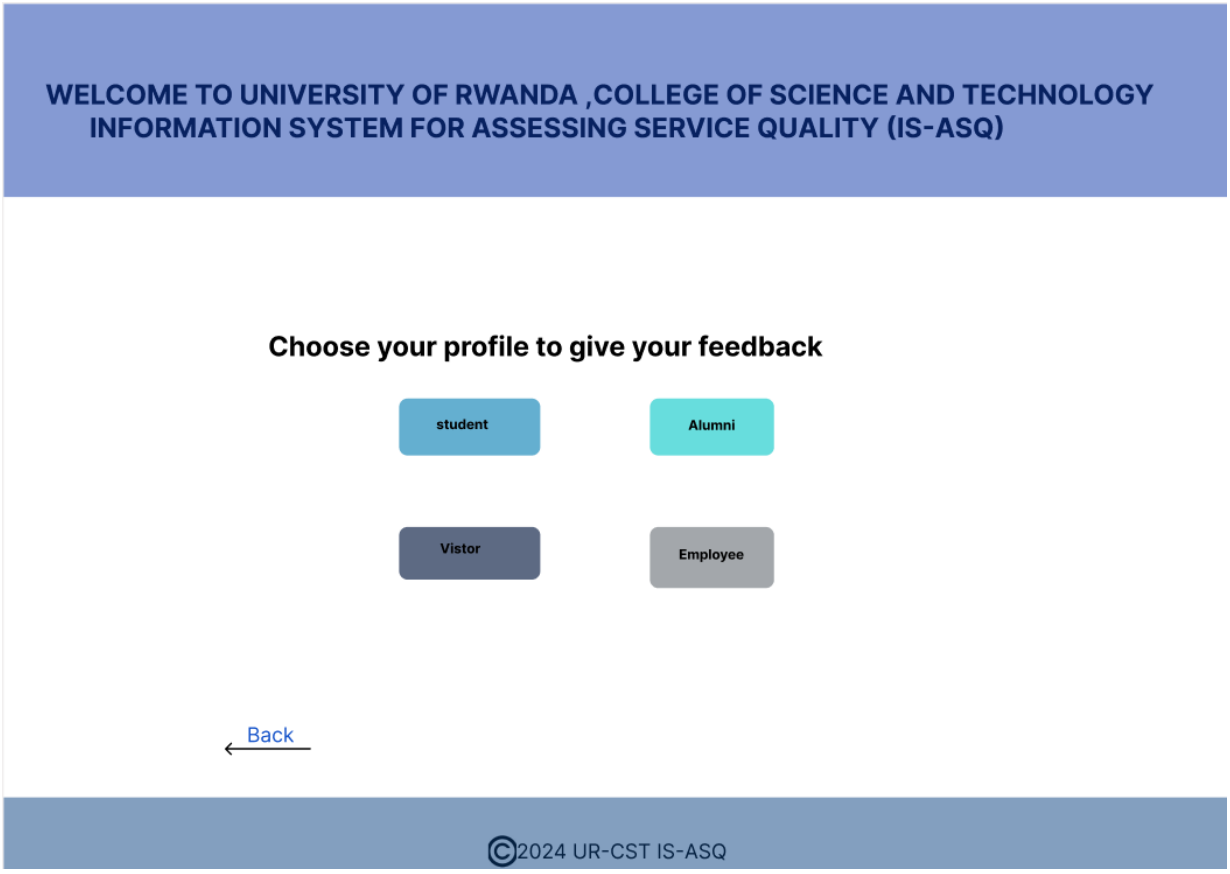

Figure 14: IS-ASQ Page of Respondents Categories

5.3.3. Page of Feedback Categories

This page shows available services to be assessed

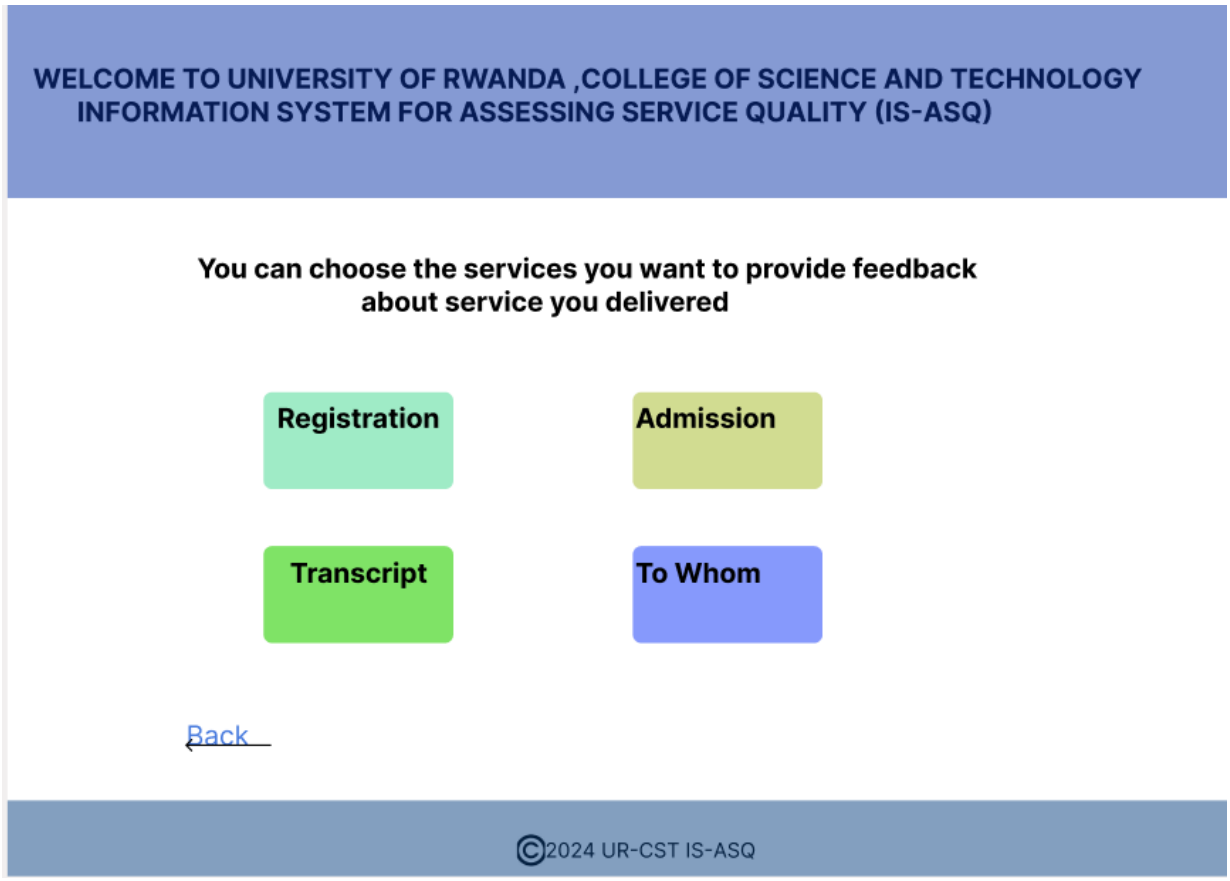

Figure 15: IS-ASQ Page of Feedback Categories

5.3.4. Service Assessment Page

This page shows assessment questions and various levels of satisfaction on service delivery

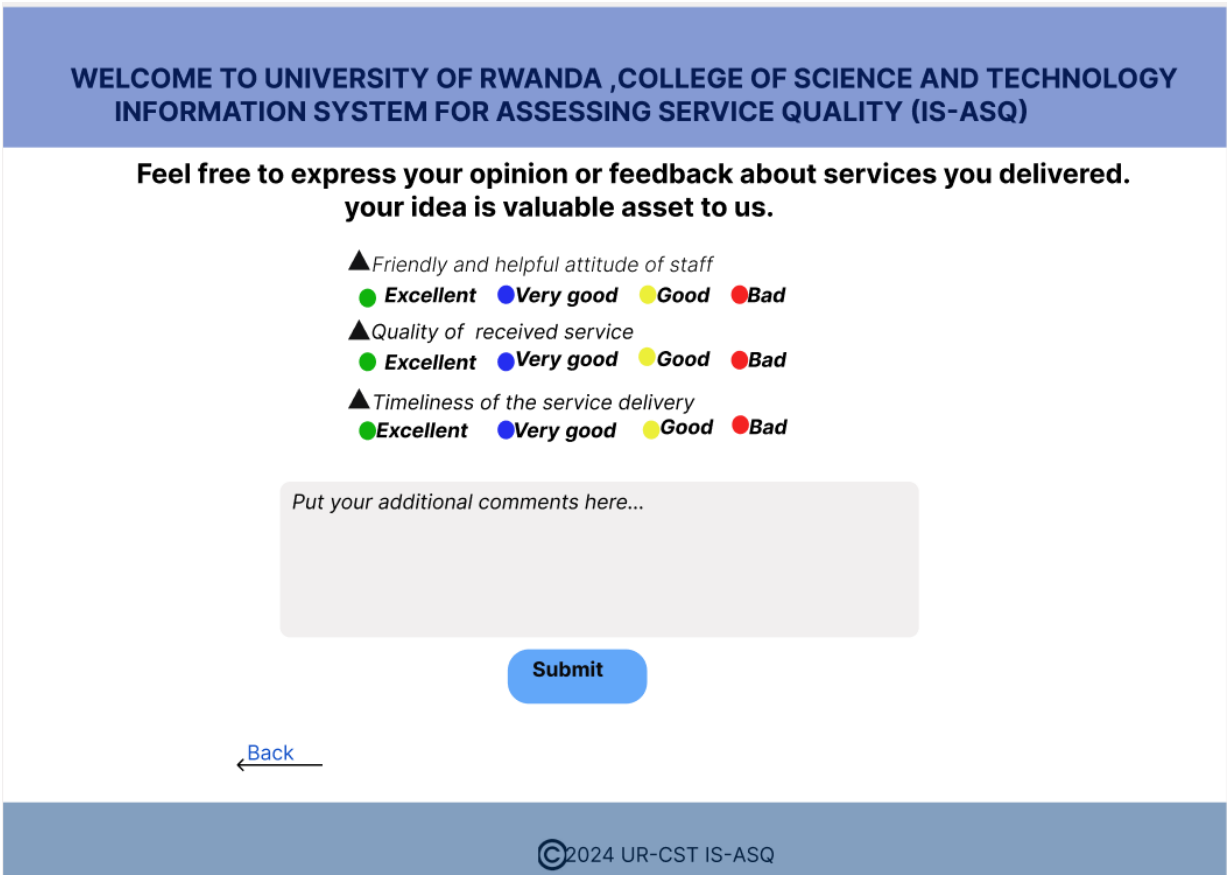

Figure 16: IS-ASQ Page of Service Assessment

5.3.5. Service Provider Login Page

This page is only for service providers where they have to use their official email to request access to the service assessment report.

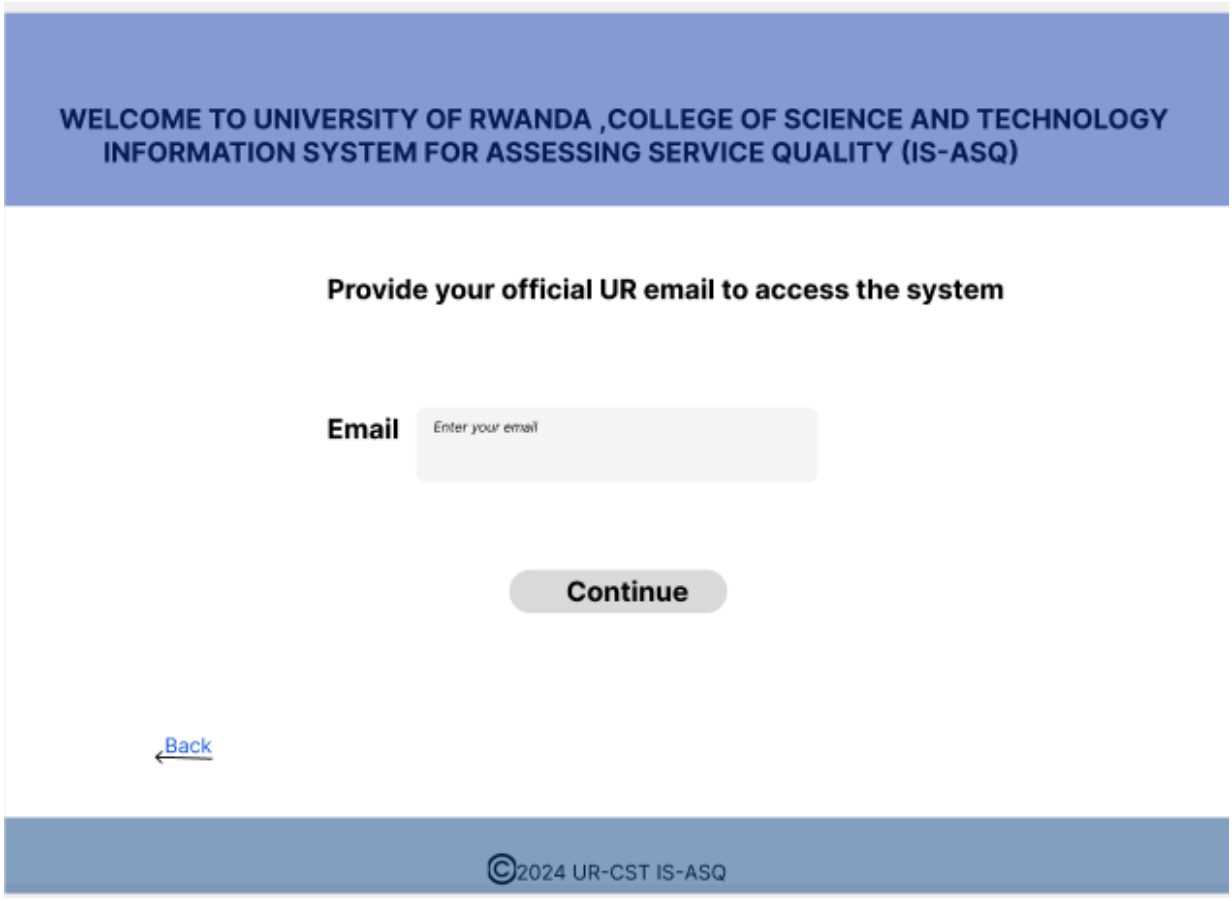

Figure 17: IS-ASQ Login Page

5.3.6. Service Provider Login Authentication Page

This page serves as the authentification where for a provided valid official email, a passcode will be sent to the email inbox and the user will need to provide it to continue.

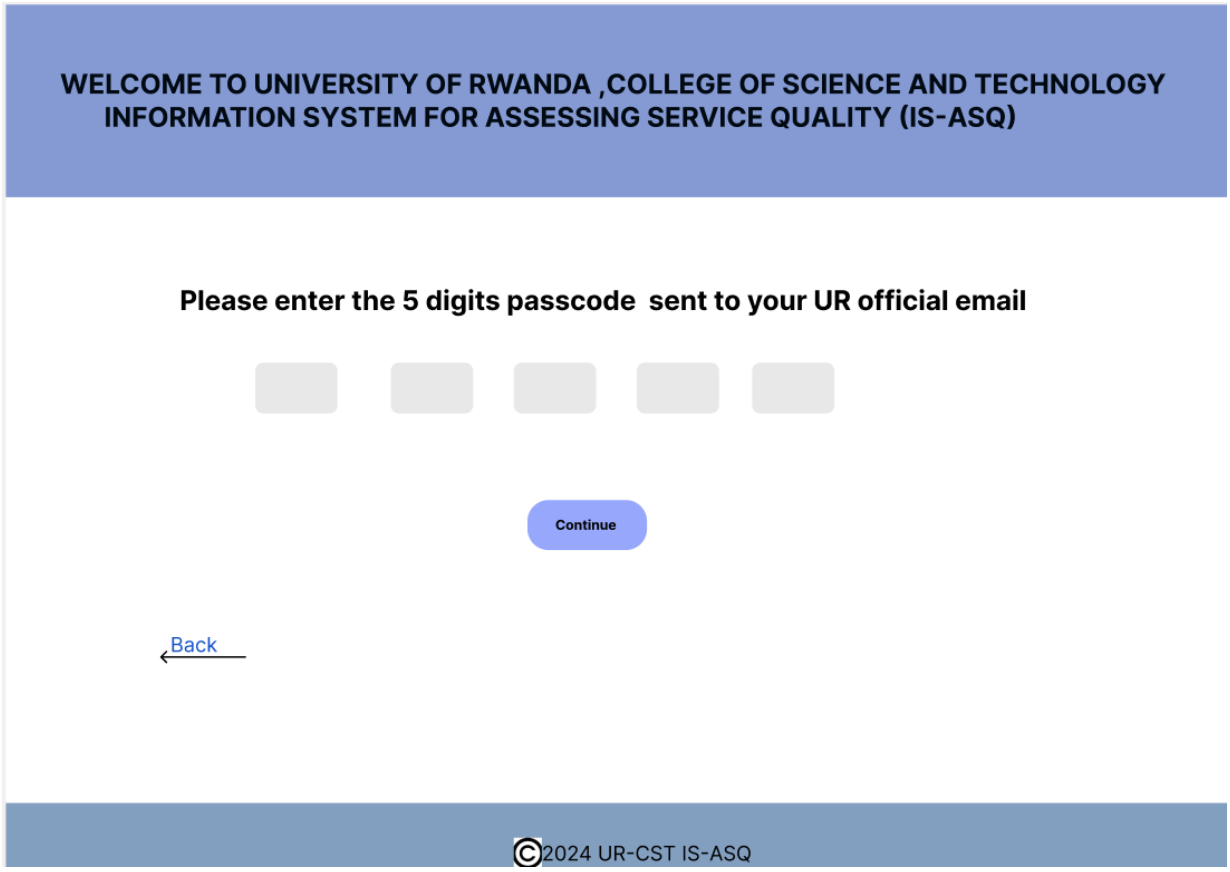

Figure 18: IS-ASQ Login Authentication Page

5.3.7. Customer Satisfaction Report Page

This page displays service assessment results, tailored for individuals with authority over all four selected services, such as the college's Principal. However, users like the college's registrar or the dean of the school will only see results for their respective offered services.

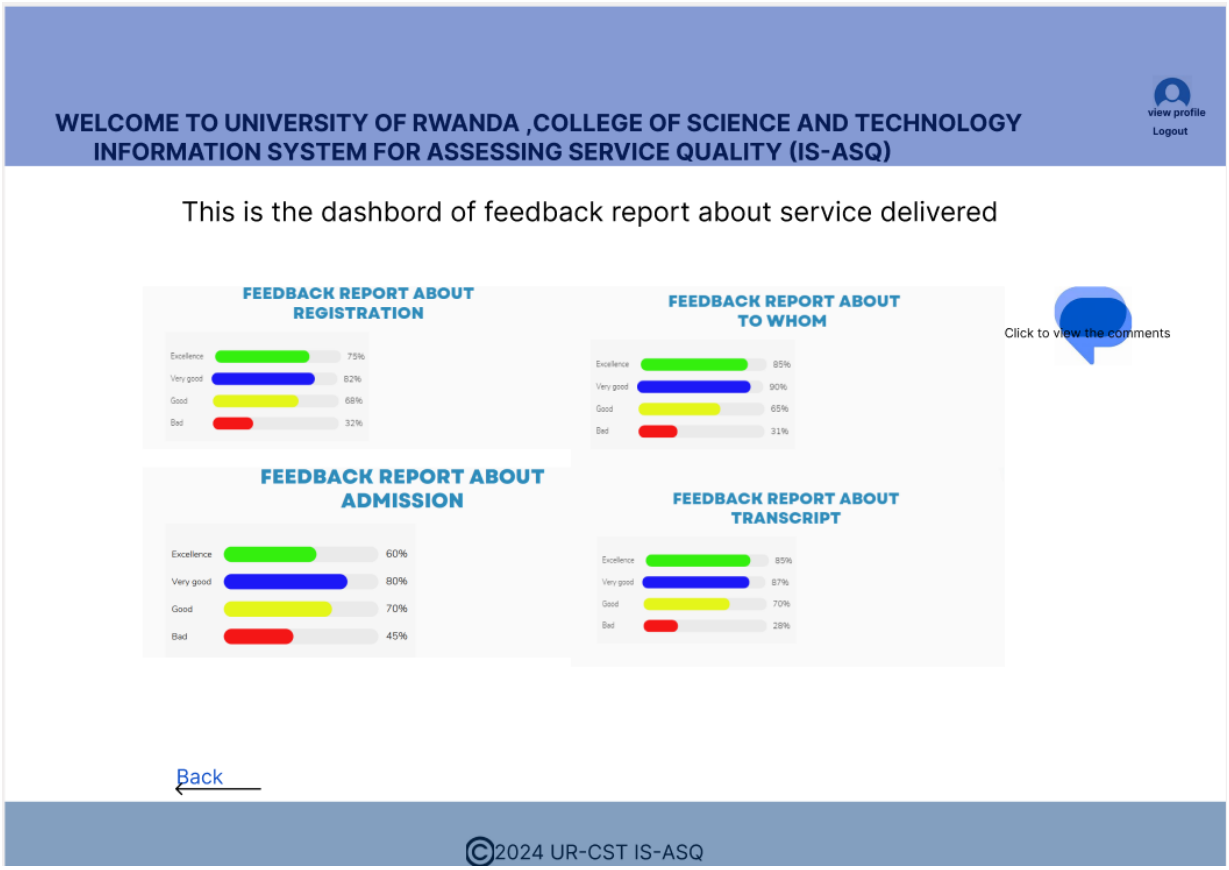

Figure 19: IS-ASQ Customer Satisfaction Report Page

From the designs as seen above objective 3 (To design the information system for assessing the service quality of the selected services in the college's registrar's office, departments, and schools) has been achieved.

CHAPTER 6. CONCLUSION, RECOMMENDATIONS AND FUTURE WORK

6.1. Conclusion

This research shows that almost all stakeholders prefer online-based feedback mechanisms and the digitalization of paper-based services. The Design of the Information System for Assessing Service Quality (IS-ASQ) has been completed, focusing on enhancing service delivery and customer satisfaction at the University of Rwanda, College of Science and Technology. The system's user-friendly interfaces, including the home page, respondent categories, feedback categories, service assessment page, and service provider login and authentication pages, have been designed to ensure accessibility and ease of use for all stakeholders. By designing IS-ASQ as presented in Chapter 5 of this research, the main objective has been achieved.

6.2. Recommendations and Future Work

6.2.1. Completion of SDLC Phases for IS-ASQ

Future research should focus on completing the remaining stages of the Systems Development Life Cycle (SDLC) for IS-ASQ, including development, testing, implementation, and maintenance.

6.2.2. Continuous Improvement

It is recommended to continuously monitor and evaluate the performance of IS-ASQ during and after implementation to identify areas for improvement. Regular updates and enhancements should be made based on user feedback and technological advancements.

6.2.3. Expansion of Services

Future work should consider expanding the scope of IS-ASQ to include more services offered by the university. This will provide a more comprehensive assessment of all services and improve overall customer satisfaction.

6.2.4. Integration with Other Systems

Integrating IS-ASQ with other existing systems at the university, such as the UR-IEBMIS, can streamline operations and provide a more holistic view of service quality.

6.2.5. Research and Development

Further research should be conducted to explore new methodologies and technologies that can be incorporated into IS-ASQ to enhance its functionality and effectiveness.

By addressing these recommendations and completing the remaining SDLC stages, IS-ASQ can significantly improve service quality and customer satisfaction at the University of Rwanda, College of Science and Technology.

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APPENDIX I

UNIVERSITY of RWANDA

Research and Postgraduate Studies (RPGS) Unit

Questionnaires

Introduction

I am Eric NDAYISHIMIYE, a postgraduate student at the University of Rwanda, who is currently carrying out research to determine the Quality of Service (QoS) levels of our Institutions. This questionnaire is not intended to reveal any personal information, as names, ages, departments, etc.… are not captured, please feel free to give us your answers to the best of your ability.

Category A: Registrar's Office

Section 1: Staff.

1. What are the steps followed while admitting students?
2. What are the steps followed during students' registration?
3. How many admissions support requests do you receive per semester? **Tick as appropriate**

1-20		21-50		51-100		101-500		500-above	

4. How many admissions support requests do you handle per semester? **Tick as appropriate**

1-20		21-50		51-100		101-500		500-above	

5. How many registration support requests do you receive per semester? **Tick as appropriate**

1-20		21-50		51-100		101-500		500-above	

6. Should the IS-ASQ address the following requirements? **Choose as appropriate**

Response at real time	Y / N	Generate report	Y / N	Secure	Y / N	Mobility	Y / N	Reliable	Used for Decision Making	Y / N

7. Is there a need for both online based feedback mechanism and digitalization for services rendered within the College? **Tick as appropriate**

Yes		Neutral		No	

Section 2: Students

1. What are the steps followed while applying for admission?
2. What are the steps followed during registration?
3. How often did you seek support on admission? **Tick as appropriate**

0		1		2		3		4-above	

4. What was the problem and how long did it take to be resolved?
5. How often did you seek support for registration? **Tick as appropriate**

0		1		2		3		4-above	

6. What was the problem and how long did it take to be resolved?
7. Is there a need for both online based feedback mechanism and digitalization for services rendered within the College? **Tick as appropriate**

Yes		Neutral		No	

8. Should the IS-ASQ address the following requirements? **Choose as appropriate**

Response at real time	Y / N	Generate report	Y / N	Secure	Y / N	Mobility	Y / N	Reliable	Used for Decision Making	Y / N

APPENDIX II

UNIVERSITY of RWANDA

Research and Postgraduate Studies (RPGS) Unit

Questionnaires

Introduction

I am Eric NDAYISHIMIYE, a postgraduate student at the University of Rwanda, who is currently carrying out research to determine the Quality of Service (QoS) levels of our Institutions. This questionnaire is not intended to reveal any personal information, as names, ages, departments, etc.… are not captured, please feel free to give us your answers to the best of your ability.

Category B: Departments and Schools

Section 1: Academic Staff.

1) What are the steps for issuing a transcript?
2) What are the steps for issuing a "To Whom It May Concern" letter?
3) How many transcript requests do you receive per semester? **Tick as appropriate**

1-10		11-30		31-60		61-120		121-above	

4) How many transcript requests do you handle per semester? **Tick as appropriate**

1-10		11-30		31-60		61-120		121-above	

5) How many to whom it may concern requests do you receive per semester? **Tick as appropriate**

1-10		11-30		31-60		61-120		121-above	

6) How many to whom it may concern requests do you handle per semester? **Tick as appropriate**

1-10		11-30		31-60		61-120		121-above	

7) Is there a need for both online based feedback mechanism and digitalization for services rendered within the College? **Tick as appropriate**

Yes		Neutral		No	

8) Should the IS-ASQ address the following requirements? **Choose as appropriate**

Response at real time	Y / N	Generate report	Y / N	Secure	Y / N	Mobility	Y / N	Reliable	Used for Decision Making	Y / N

Section 2: Students

1. What are the steps followed while requesting/applying for a transcript?
2. What are the steps followed while requesting/applying for a "To Whom It May Concern" letter?
3. How often did you apply for a transcript per semester? **Tick as appropriate**

0		1		2		3		4-above	

4. What was the purpose and how long did it take to be given a transcript?
5. How often did you apply for a "To Whom It May Concern" letter per semester? **Tick as appropriate**

0		1		2		3		4-above	

6. What was the purpose and how long did it take to be given a "To Whom It May Concern" letter?
7. Is there a need for an online based feedback mechanism and digitalization for services rendered within the College? **Tick as appropriate**

Yes		Neutral		No	

8. Should the IS-ASQ address the following requirements? **Choose as appropriate**

Response at real time	Y / N	Generate report	Y / N	Secure	Y / N	Mobility	Y / N	Reliable	Used for Decision Making	Y / N